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CIVIL ENGINEERING.

On the Asphalted Macadamised Roads lately laid down in Paris. Compiled from the 'Annales des Ponts et Chaussées, 1850.' *By* M. De Coulaine, *Engineer of the 'Ponts et Chaussées.'**

Continued from page 228.

Chapter VII.—Maintenance and Repair of Asphalted Roadways.

The powers of resistance and the durability of this kind of roadway being now beyond question, other points not less important remain to be discussed.

The first which calls for serious examination is the mode of maintenance. If, in fact, the mode of executing a roadway has an importance whose gravity is beyond discussion, the methods employed for its maintenance have a much greater influence upon its goodness and the services it is able to perform. A road, let it be ever so well constructed, if it be not properly maintained, must soon become useless; whilst, on the contrary, proper methods of repair may correct, or at least attenuate, any original defect.

The maintenance of any roadway has two objects in view: one being to repair and efface any alteration or deformation produced by the traffic; the other being to replace progressively, or at slight intervals, the waste produced by the gradual wearing down of the materials.

The earliest system employed by M. de Coulaine consisted, 1st, as far as partial repairs were concerned, by "picking" it all over in the first place, and then laying about $\frac{3}{4}$ inch of hot mastic over the whole surface.

2d, As far as the general wearing away of the roadway was concerned, by well clearing its surface, and covering it with a layer of mastic of the requisite thickness, applied hot.

* From the London Architect for September, 1851.

Very serious inconveniences are attached to both of these methods. For they require that the whole assemblage of cauldrons and experienced workmen should be sent for on every occasion; and they are wanting in the first condition of a theoretically perfect system of maintenance, inasmuch as they are not of a nature to enable the defects of a roadway to be repaired without proceeding to a reconstruction of the whole structure.

The process about to be described, obviates these inconveniences. After having perfectly cleaned the place to be operated upon, a layer of liquid bitumen (formed of 3 parts of oil of resin and 1 of Bastenne bitumen) is to be laid on with a brush. Over this layer, pounded asphalte is to be moved backwards and forwards with a broom, until the bitumen can no longer take it up; then some sand is to be sifted over the whole. When the carriage wheels have passed over the surface, the sand which has not combined with the asphalte should be removed with a broom. After a few days a layer of mastic, from $\frac{3}{4}$ to $1\frac{1}{4}$ inch in thickness, and of a great degree of resistance, becomes formed over, and intimately connected with, the subjacent bitumen, by the action of the traffic and the natural affinity of the different materials employed.

The bituminous oil above described must be prepared in the shop previously to the application. The bitumen is melted in the cauldron first, and the oil of resin indicated is subsequently added; as soon as the combination is perfect, the oil is removed from the fire in order to avoid useless evaporation.

To ensure the rapid setting of the bituminous mastic, it is necessary, 1st, that the layer of oil be very thin, and spread in about the proportion of 0·07 lb. avoirdupois per foot superficial; the quantity of asphalte this will take up would amount to about 0·21 lb. per foot superficial. 2d, That the quantity of sand be not too considerable; it would be sufficient, to ensure this, simply to observe the precaution indicated, and to remove the useless sand as soon as the traffic has passed over it. 3d, That the operation be carried on in fine weather, that is to say, between May and September: the sun's heat appears to be indispensable to ensure success.

It is also preferable to use asphalte which has been pulverised cold, because it contains more bituminous matters than that which has been pulverised by the aid of heat. When the surface of the roadway to be repaired is very rugged, it will be necessary to substitute asphalte in small fragments for the asphalte in powder, and the dimensions of these fragments should be in proportion to the ruggedness.

This mode of repair was first tried at the end of the summer of 1845. Subsequently it has been the only one used, to the exclusion of all others, and has invariably produced the best results, and it may be applied either to partial or general repairs.

Portions of roadways in a very defective state, either from the nature of the material, or on account of the advanced season of the year when they were executed, or, perhaps, on account of their foundation, have been repaired by this method with the most perfect success. The bituminous oil appears to have entered these parts, to have rendered them more elastic, and to have, in a manner, re-soldered the particles at a certain depth. It has, at the same time, by its combination with the asphalte and sand, covered them with a layer of mastic, which has

re-established the solidity of the structure, and restored its even surface; thus the whole process may be said to fulfil the conditions stated to be those requisite to constitute a perfect system of maintenance.

Moreover, this system, which is so easy in its application, only costs about one-half of the one in which the bituminous mastic is applied hot.

Chapter VIII.—New Process of Constructing Roadways in Bitumen without Cauldrons, and with Cold Mastic.—Application to the Planking of Wooden Bridges.

The experimental essays for the maintenance above described have had another advantageous result; they naturally led to the endeavor to lay down a roadway in a similar manner. In this new system, as in that lastly described for the maintenance, the asphalte and the aggregating substances are laid cold. It may be described as follows:—

Seyssel stone is comminuted into pieces of the size usually employed for the construction or repair of roads. The fragments which are too small, are separated by passing the stones through a sieve, whose openings are $\frac{3}{4}$ inch wide by two inches long: the larger fragments thus separated are covered with liquid coal tar and shaken in the sieve, so as to ensure their being entirely covered by that liquid. This operation is intended to facilitate the aggregation of the calcareous asphalte. The macadam, which serves as a foundation, is then covered with a layer of these materials from $1\frac{3}{4}$ to 2 inches thick; the layer should be well rammed, with rammers weighing about 45 lbs.

When the fragments of asphalte are thoroughly bound together, the interstices are to be filled in with a bituminous sand previously prepared, as follows:—

Seyssel Asphalte, in powder,	202·5 lbs.
Ordinary Sand,	135·0
Oil of Resin,	16·9
Bastenne Bitumen,	5·7

These materials are combined in the usual manner. They are then poured out, and divided by a toothed rake into small fragments, which are exposed to gentle heat with some asphalte in powder to prevent their re-combination. At the time of use they are to be separated from the asphalte in excess by means of a sieve, and sprinkled with a proportion of about $\frac{1}{100}$ to $\frac{3}{100}$ of the oil of resin.

The sand thus prepared is to be spread over the roadway, and forced by a scraper into all the spaces left by the asphalte stones, without, however, covering the latter, which are to be left apparent; the mastic is then to be further consolidated by being beaten with a flat tool, so as to fix the sand in the interstices. The quantity thus introduced may be estimated at from 2 lbs. to $2\frac{1}{4}$ lbs. per foot superficial. The ramming is then resumed until the layer of macadam is sufficiently compressed. To prevent the mastic or the coal-tar from sticking to the rammers, they should, from time to time, be dipped in water; or this inconvenience may be obviated by the use of a little asphalte in powder. But this part of the operation is far more satisfactorily performed if a cylinder be used. Whatever method be employed, the traffic of a few days will give all the consolidation required.

If the surface of the roadway be closely examined, a great number of bruised or broken fragments of the asphalte in powder may be observed, owing to the fact that the asphaltic limestone is not sufficiently rich in bituminous matters. At the expiration of a certain period these stones become partially covered by the sand which protects them, and combine with the dust and splinters of the asphalte. However, to ensure a prompter and more complete aggregation, it is advisable to moisten the surface of the macadam with a layer of bituminous oil, and to cover it with asphalte and sand, by means of a sieve, as has been described for repairs.

It is of the greatest importance that the roadway which serves as a foundation for the asphalte should be of a very great degree of hardness; without this, the consolidation of the bituminous mastic would take place with difficulty, the oleaginous matters would become intermingled with the stones, and would communicate to the roadway a degree of softness which it would never lose.

This system of making the roads cold, like the system of repairing them in a similar manner which led to it, and of which it may be considered the natural consequence, has many very important advantages. Firstly, it is so simple and easy that it can be performed by workmen totally unused to the class of material, the bitumen, which may be said to characterize the process; and the success thus becomes, to a great extent, independent of the care or skill of the workmen. It requires no heat, nor any of the cumbrous machinery of the cauldrons, and obviates the dangers attending the excess or falling short of the degree of heat.

Secondly, the application can take place at any season of the year, provided the foundation be solid, an advantage which is far from being possessed by the pavements requiring heat for their application. Some trials made in the winter 1848-49, have indeed been as successful as those made in summer. As the aggregation is produced by compression and by the action of the traffic itself, this system appears to present the greatest guarantees of solidity.

Lastly, the layer of asphalte thus applied, offers in its composition and properties, the most striking analogy with ordinary macadamised roads. It forms, in fact, a species of macadam, in which the asphalte performs the functions of the broken stones, and the malleable mastic those of the sand and of the detritus. By means of the portions of asphalte which appear on the surface occasionally, a resistance is offered to the wheels of the carriages; whilst a foot-hold is given to the horses by the soft mastic which forms the remainder of the combination. This kind of roadway, therefore, unites two advantages, apparently opposed to one another: it presents a firmer surface than the pavings executed warm can do to the rolling traffic; and also, it obviates in the most complete manner, all danger arising from slipperiness.

It follows, from the composition above indicated, that the changes of the atmosphere affects this kind of roadway to a much less extent than they do any others of a similar nature. Indeed, of the four elements of which the bituminous mastics are composed, the tar (whether natural or the result of distillation) is the only one liable to vary in its consistence; the limestone and the sand remain always in the solid state, and the oil

preserves its fluidity under the greatest cold. The greatest degree of uniformity of character will then be attained by maintaining the tar in the lowest possible proportions.

In the asphaltic limestone, the solid element prevails to such an extent that it ceases to be fusible; in the malleable mastic, on the contrary, the oil is in excess. It is, from this, easily conceivable that the two principles in question should be but little subject to variations of temperature, and that the kind of macadam produced by their combination should neither soften in an extraordinary manner during the summer, nor cease to afford foot-hold to horses in winter.

It also follows, from the presence of the asphalte, that the carriages which may stand upon the macadam do not leave very strong marks, and that the roadway is not exposed to the same deformations from this cause, which can be observed in those where the hot mastic is used.

The facility with which this sort of roadway (whose cohesion is but feeble, and which contains hardly any other elements than the asphalte and the bitumen) can be opened, and with which it can also be reinstated, allow the repairs of gas or water pipes, of sewers, or of any other description of under-ground works, to be carried on without difficulty. In such cases, the only precaution to be observed is, to ensure the consolidation of the foundation before the bituminous mastic is employed. The indications of any rupture in water pipes are even remarkably rapid in displaying themselves, and very easily detected.

The experiments connected with the new system of forming these roadways with a cold mastic were executed in the month of June, 1848. At first they were executed on a small scale, but in the spring of 1849 greater extension was given to them, and the results have been so far satisfactory, that the whole, or nearly the whole, of the Boulevards have been paved in this manner. But M. de Coulaine still appears to prefer the formation of the covering of vaults or arches by the use of hot mastic.

Application to the Planking of Wooden Bridges.—On wooden bridges the use of bituminous matters laid cold is, however, indispensable.

As wood contracts or expands, with the alterations of the temperature, to a great extent, the mastic applied hot, on account of its adherence to the surface of the wood, must participate in its movements, and must, therefore, crack. In the pavings usually executed for foot-passengers only, this danger is obviated by the interposition of a rather open cloth, or by that of a light layer of sand. But for a carriage road this precaution would not be sufficient, because, if two contiguous planks should happen to warp in different manners, an open space might be formed over one of them, and the traffic passing over it would necessarily cause the mastic to be broken; the successive movements of the planking under the passage of carriages would produce the same result. It is possible that, by observing the same precautions in laying the planking which would be observed in laying a floor, this danger might be avoided; but the success of this process, besides being in itself expensive, is doubtful. With the bitumen applied hot, it would then appear necessary to lay the roadway on a layer of broken stone at least 4 inches thick, thus neutralising entirely any danger from the action of the wood, but at the same time presenting the serious inconvenience of uselessly loading the bridge.

With the system of applying the bituminous mastic cold, the interposition of this layer ceases to be necessary; admitting, indeed, that the dilatation or contraction of the wood, by communicating itself to the mastic, might give rise to some cracks, they would soon disappear under the action of the traffic, which, in fact, produced the first aggregation. By this means the planking of bridges becomes protected from the action both of traffic and of weather; and one of the most important difficulties in the execution of such works, or rather in their maintenance, becomes satisfactorily solved.

When the passage over a bridge is not very frequent, it may possibly be sufficient to cover the planking with a few coats of liquid mastic applied with a brush, according to the system already indicated for the maintenance. The fissures likely to take place at the joints of the planks will be but of little importance; and in this manner a very light roadway may be obtained particularly suited to suspension bridges.

Other Methods of using the Mastic Cold.—One of these only differs from the method above described insomuch as the single layer of asphaltic stone is replaced by two layers of equal thickness,—the first consisting of silicious stones covered by a bituminous gangue, and the second of asphaltic fragments prepared as has been already described.

The stones destined for the bottom layer should be separated from too minute fragments by means of a sieve or screen, whose wires should be $\frac{3}{4}$ inch apart; or from too large fragments by the use of another screen, whose dimensions should be $\frac{1}{2}$ inch less than the thickness to be given to the roadway. Moreover, they must be perfectly dry and clean.

The gangue with which they are to be covered may be applied in several manners. The most simple is, to dip them in coal tar, to let them dry thoroughly, agitating them occasionally on the sieve used to dip them, to throw them into a mixture of two parts of asphalte, pulverised cold, to one of sand, covering them entirely with it, and stirring the whole well together with a spade. The stones are to be left for some time in the mixture, to allow the coal tar to take up as much of it as possible. A species of bituminous coating, similar to the one applied by the brush for the purpose of repairs, is thus formed over each stone.

The materials prepared in this manner are used first; after covering them with the broken asphaltic stone, the aggregation of the roadway is effected by the rammer, and the addition of the mastic, as before.

In another essay, the bituminous macadam was entirely composed of silicious stones, covered by a gangue much thicker, applied by dipping the stones into a cauldron of hot mastic, formed of the following materials:—

Bastenne Bitumen, ...	20 lb.
Oil of Resin, ...	4½
Asphalte of Seyssel, ...	135
Sand, ...	90

At the end of about a quarter of an hour the stones are withdrawn from the cauldron, and placed on a sieve for a short time, so that the bituminous matter remains in excess; they are then thrown into and stirred up with the asphalte in powder: they are afterwards to be separated from the asphalte, and the fragments of the mastic which have not adhered to

the stone. These fragments themselves are also to be removed from the asphalte, and laid aside.

A day or two before these stones are to be used, coal tar is to be poured over them, in proportion of about 1 in 100 of their weight; they are to be well turned over with a rake, so as to spread the coal tar equally over their surface. The fragments of mastic are also to be covered with coal tar.

The stones are to be used in the usual way. After they have been rammed, or pressed down with a roller, their interstices are to be filled in with fragments of mastic, already mentioned; the roadway is again compressed, and during a certain time again given up to public traffic.

When it is perfectly consolidated, it should be perfectly cleaned from dust or mud, and the cavities upon its surface filled in with a bituminous sand, prepared cold, and containing 9 parts of asphalte in powder, to 6 of sand, and 1½ liquid bitumen with a base of oil of resin; this sand being fixed in the said cavities by means of a spade. Lastly, after the excess of sand is cleared away by a broom, the roadway is to be covered with a layer of asphalte applied with a brush as before described.

The stones should be passed through the sieves mentioned in the description of the last essay; it is also advisable to dry and warm them round the cauldrons, before putting them in. The principal condition in the selection of the stones should be rather that they resist crushing; for there are many stones sufficiently hard to wear away iron, which are easily splintered by smart shocks, or comminuted by heavy weights. Such stones as are the most difficult to break are the best; and they should, moreover, be very angular, in order that the mastic may adhere to them readily. The hard sandstones answered best.

The mastic with which these stones are to be covered ought to be submitted to the essay above mentioned, and the impression should be about ½ inch deep at the utmost. When it becomes too thick for the stones to be easily stirred about in it, the addition of a little pure oil of resin will restore its fluidity.

The quantity of mastic which sticks to the stones in this operation amounts to about two-thirds of their weight; the substances added to facilitate and complete the aggregation of the roadway form on the average one-tenth of the total weight of the materials entering into its composition. It follows that 100 parts of the roadway must contain nearly the following proportion of the several ingredients, viz:—

Silicious stones, ...	54 parts.
Mastic, applied hot, ...	36
Ditto, cold, ...	10
	100

The materials especially employed to facilitate the aggregation are then the $\frac{46}{100}$ of the total weight; that is to say, that they nearly correspond with the spaces which are left between the silicious matters. At the end of a certain time the mastic and the gangue, by a gradual deformation due to the pressure of the traffic, fill all the spaces; the silicious stones then touching one another, the aggregation is complete, and wheels can no longer penetrate. The gangue preserves the stones from the action of the wheels, and to a great extent prevents their communition.

The two last methods indicated give rise to a considerable economy. Even should this end be attained at the expense of a certain degree of solidity—which is by no means admitted—there can exist no reason to doubt but that the facility of repairing with cold materials, would counterbalance any inconvenience which might arise. The last method, which is a combination of the others, appears to be the most satisfactory solution of the difficulties attached to the use of the bituminous macadam.

In another experiment, the asphaltic limestone dipped in coal tar, was employed without any mastic. The aggregation took effect with a certain degree of ease, but in the manner in which it usually takes effect in roads composed of calcareous materials; that is to say, that the fragments of the asphalte were broken, and the small particles resulting thencefrom filled up the interstices. The asphaltic limestone, it is true, under the action of the traffic, had become compressed and flattened out, owing to the bituminous elements it contained. But these materials, on account of their small proportion, could not prevent the surface of the macadam from becoming pulverulent, from falling to pieces, or yielding to the same kind of causes of decay which destroy ordinary roadways. Under such circumstances a road thus constructed could not have lasted under an active traffic, or at least the rate at which it would have worn away would very soon have led to its final destruction. This was proved by the fact that, after the road had been swept, a fresh layer of asphaltic dust was formed in a few days, and so on consecutively.

The cause of this is that the asphalte is not sufficiently rich in bituminous matters; to remedy this defect all that was required was to supply the deficiency by introducing, into the macadam, the quantity of bitumen required, which seems to be successfully effected by the use of the cold materials. When the asphaltic stones had become sufficiently aggregated by the action of the traffic, M. de Coulaine, on some occasions, had the surface swept so as to remove all the particles of the asphalte in powder; it was then painted over with oil, and the latter covered with asphalte and sand, as has been previously described. After a few days' wear the roadway presented a perfectly aggregated surface, and has constantly maintained that character.

It is to be observed that the elastic mastic should protect the stones throughout the whole thickness of the road, and that it serves to render the aggregation much more prompt and complete. There is also another very important advantage connected with it, viz: that it prevents horses from slipping, and thus obviates the most serious inconvenience hitherto reproached to bituminous roads.

Chapter IX.—Of the Cost of Making and Maintaining Roadways of Bitumen.

We have above described three leading systems for making bituminous roadways—namely, 1. When the materials are used hot. 2. When they are used cold, fragments of asphalte and soft mastic being employed. 3. The same system, excepting that the asphaltic stones are replaced by silicious stones, enveloped in a bituminous gangue.

The prime cost of each of the systems will be given, according to the rate of wages and the price of materials paid in Paris.

1. *Mastic, &c., applied Hot.*—When six cauldrons were employed at a time, the men required to work them consist of

1 Foreman, at per day, ...	4·00 fr.
3 Firemen, or stokers, per day each, 2 fr.. . .	6·00
1 Carrier, at per day, ...	2·00
1 Beater, or layer, at per day, . . .	2·00
3 Laborers to pound the asphalte, 2 fr. per day,	6·00
Total,	20·00

Such a gang of men can lay about 22 cauldrons full of the mastic per day; and as each cauldron holds 0·07 metre cube of mastic, they can lay about 1·54 metre cube; or the cost per metre superficial, and per centimetre thick, for labor only, is about, say,

Labor per metre superficial, ...			0·13 fr.
Materials—			
Each cauldron contains:			
90 kilogrammes of asphalte, at 0·10 fr. . .		9·00 fr.	
7·5 " Bastenne bitumen, at 0·38		2·85	
2·5 " Oil of resin at 0·42 . .		1·05	
6·0 " Sand, at 0·003 . .		0·18	
Total,		13·08 fr.	
As each cauldron produces 0·07 metre cube of the mastic, the metre superficial, 1 centimetre thick, costs			1·87 fr.
Warming the cauldrons, including the one in which the asphalte is pounded, ...			0·20
Carriage of plant to works			0·05
			2·25
Add 10 per cent for superintendence, &c.,			0·23
Total,			2·48 fr.

Or, the price per metre superficial, and per centimetre in thickness, is, as above, 2·48 francs; or, in round numbers, about $2\frac{1}{2}d.$ per foot superficial.

But it must be observed, that in execution the real thickness exceeds the one theoretically assumed. Thus, if the rules be laid for a thickness of $1\frac{1}{8}$ inch in thickness, in fact it will be $1\frac{3}{8}$ inch, owing to an increase, towards the centre especially, which takes place at every pouring out of the liquid. The price will have to be augmented proportionally.

2. *When the Materials are used Cold; fragments of Asphalte and Soft Mastic being employed.*—The price per metre superficial may be estimated thus:—

22·50 kilogrammes of material, at 10 cents per kilog.	2·25 fr.
Breaking and preparation, ...	0·11
Use of tools and machinery, . . .	0·03
Superintendence and costs, ...	0·24
Total,	2·63 fr.

Or, the price per metre superficial, and per centimetre in thickness, is, as above, 2·63 francs; or, in round numbers, about $2\frac{63}{100}d.$ per foot superficial.

When the Materials are used Cold; but the Mastic used Soft, and the Silicious Stones covered with a Bituminous Gangue.—We have already seen, that to execute 1 metre superficial, and 1 centimetere in thickness,

it requires about 12·15 kilogrammes of silicious stones, and 10·35 kilogrammes mastic, used either hot or cold.

The 12·15 kilog. silicious stones will cost about		0·10 fr.
The 10·35 kilog. mastic consist of—		
5·64 kilogrammes Asphalte, at 0·10 fr.	0·56	
0·75 " Bastenne bitumen at 0·38	0·28	
0·20 " Oil of resin, at 0·42	0·08	
3·76 " Sand, at 0·003	0·01	
		1·03 fr.
Preparation and breakage of stones,		0·10
Heating mastic for ditto,		0·07
Carriage of tools and materials,		0·03
Superintendence and costs,		0·12
Total,		1·35 fr.

Or, the price per metre superficial, and per centimetre thick, of the roadway formed with silicious stones in a bituminous gangue, is, as above, 1·35 franc; or, per foot superficial, about $1\frac{35}{100}d.$

It would appear from this, that the latter mode of construction is notably more economical than the others.

To all these different prices, however, we must add the cost of forming the original foundation. As has been previously observed, a layer of broken stone, consisting of silicious materials, as clean as possible, resting upon a bed of sand, which shall have been perfectly aggregated, and proved by the ordinary traffic, is, at the same time, the simplest, the most economical, and the only one which offers sufficient guarantees of solidity. The price of such a layer of stone will vary, of course, according to the price of the stone itself. But if we assume it to be about $\frac{3}{4}d.$ per foot superficial, we shall, in all probability, exceed the average.

Applying these prices to a roadway with a thickness of 4 centimetres ($1\frac{9}{16}$ inch,) the following will be the cost of the three different systems described:—

1. For a roadway laid with asphalte used hot,	10·67 fr. per metre.
2. Ditto do. cold, with broken asphalte,	11·27 "
3. Ditto do. with silicious stones coated with a bituminous gangue,	6·19 "

Chapter X.—On the Annual Wear, and the Expense of Maintenance, of Roadways in Bitumen.

We have seen that the action of traffic upon this description of roads is such as to produce but very trifling changes in their forms; and thus it would be natural to infer that, notwithstanding their want of hardness, they are not liable to be rapidly worn away. It becomes, then, very difficult to appreciate the degree of this action.

To ascertain this degree, borings were made in a portion of the roadway of the bridge of Saumur, about 21 feet 6 inches wide, after it had been in use for four years. The original thickness had been ascertained with the greatest exactitude at the time of its being laid down.

The thickness was originally	0.0425 met.
Mean ditto, after four years wear,	0·0398
The wear in that time was then	0·0027

It would thus appear that the annual rate of wear was rather under $\frac{7}{10}$ millimetre.

From careful observations, it was found that the daily average of the traffic over the bridge of Saumur is about 700 collars. The annual wear of bituminous roads may then be considered to be about 1 millimetre for every 1000 collars.

In ascertaining the number of collars, horses harnessed to every description of carriage have been counted indiscriminately, because, in the case under examination, the nature of these carriages, and the loads they bear, appear to influence the rate of wear very little. We have seen, in fact, that the pressure of the wheels only modifies the form of the roadway, without breaking it up, and that the horses' feet alone remove particles of its face. It seems probable that this action should be as destructive when horses are passing at a trot, and acting by percussion, as when they are drawing heavy loads at a smaller velocity. No account has been taken of horses not drawing, or of cattle, although—from the fact of the Cavalry School being close to the bridge, and also that Saumur is on the direct road traversed by the greater portion of the cattle sent from la Vendée to Paris—there are unusual numbers of both traversing the bridge every day. It may, therefore, be assumed, that the wear of this description of roadway does not exceed 1 millimetre per 1000 collars per annum, supposing that the wear takes place uniformly over the whole surface of the roadway.

The price of the repairs of the roadway of the bridge of Saumur was found to be 0·62 francs per metre linear, whilst the price of the maintenance of a similar surface of paved roads in the same district was found to have cost, in the same period, 0·78 francs per metre; but as the traffic on the paved roads did not attain the average of that upon the bridge, the comparison is unfavorable to the bituminous roads. If we compare the cost of the maintenance of ordinary macadamised roads, the advantage in favor of bitumen is still greater, for, with an equality of traffic, the latter would only cost about one-fourth of the former.

Chapter XI.—Roadways composed of Paving Stones bedded in Bitumen.—Application to Subterranean Passages, Vaults, and Basins, or in Stables.

In the different applications noticed hitherto, the bituminous substances are the only ones exposed to the direct action of the rolling traffic; they coat the stones entirely, and guarantee them from this action. In the application about to be noticed, the conditions are reversed. The stones receive the shock and the action of external agents; the mastic serves to bind them together.

The stones are prepared from 4 inches to 6 inches wide, from 8 inches to 12 inches long, and from 4 inches to 6 inches deep, and bedded in the mastic.

Upon a bed perfectly level, composed of cast iron plates, two iron bars from 26 to 33 feet long, $\frac{3}{8}$-inch thick, and of the depth to be given to the paving, are to be placed on edge. Their distance apart is to be such that three parallel lines of paving stones may be arranged between them, with joints of about 1 inch wide between each. They are to be maintained transversely by other bars, separating the intermediate space into compartments of from 2 feet to 2 feet 4 inches each; and the whole is to be

bound together by stirrup irons, to prevent any displacement of the longitudinal bars.

In each of these compartments the three rows in question are to be placed with their dressed face downwards; the joints breaking alternately, and the transverse joints being made very close to one another. Small gauges, about $1\frac{1}{4}$ inches high, are to be placed between the longitudinal joints. When the stones are perfectly arranged, fine sand is introduced into the joints, so as to cover them entirely, and any sand upon the face of the stones exposed, to be removed.

It would unquestionably be preferable to employ, for the mastic, the materials already indicated; but as it is never likely to be in contact with the air, it is not exposed to any dangerous evaporation, and to diminish expense, may be composed of coal tar, fresh pounded lime, and sand. It must, however, be tried in the manner before described, and should not be used if the impression exceed 2 inches or $2\frac{1}{4}$ inches.

It is then to be poured into the joints of the paving, so as to fill them up to the average height of the latter. A quantity of broken stones are to be beaten into the mastic, in order to strengthen it, and to render its deformation more difficult. Lastly, whilst it still retains a certain degree of heat, a second layer of bitumen is applied, and carefully leveled by a gauge resting on the longitudinal bars. It is indispensable that the mastic in the joints should have completed its contraction in cooling before the second coat is added; because the thickness of the latter being so much less, a different rate would ensue, and the lower surface be very undulated.

The paving stones should be very clean and perfectly dry. To ensure the latter condition, and to cause them to adhere more perfectly with the mastic, they should be placed round the cauldrons before being used. For the same reasons, it is necessary that the works be carried on under a shed.

At the expiration of a few hours, the blocks thus prepared may be removed from their compartments, which operation may be more perfectly accomplished if the iron bars be covered by a greasy earth, or any substance to prevent adhesion to the mastic; they are then piled until wanted, observing always to place the first upon a cast iron plate, to prevent its changing its form.

These blocks are laid as follows. They are placed side by side, (leaving between them joints about $\frac{3}{8}$-inch wide,) upon a form of broken stone, whose surface is to be regulated by a layer of sand of about $\frac{1}{2}$-inch thick. The sand is to be carefully dressed by means of a rule and gauges, laid to the form of the roadway. After a short time, the blocks adapt themselves to the surface of the sand by their elasticity, and they are to be made to fit it more closely by being beaten with a mallet. The joints between the blocks are then to be filled in with mastic to about $1\frac{1}{4}$ inches from the surface. The joints between the stones have been kept open to the same depth by means of the fine sand during the preparation of the blocks; the next step to be taken is to fill in completely the joints parallel to the direction of the street; the transverse ones are left open to about a depth of two inches. This portion of the work must be executed with a mastic similar to the one indicated for the bituminous macadamised roads.

It will easily be understood, from the mode of construction above described, that the blocks present, at their lower surface, stones arranged with the greatest regularity, and according to a perfectly plane surface, similar to the one they immediately rest upon. But this is not the only condition necessary to ensure a perfect even roadway, for it is also necessary that the respective blocks should be of an uniform thickness. Care, then, must be taken that the gauge bars be of identical height.

It is not indispensable that the macadam should have been consolidated by traffic before being made to serve as the foundation of the roadway. It will be sufficient to roll or ram it carefully, and its thickness may be reduced to about 2 inches.

Should it not be considered necessary to render the roadway watertight, the joints between the blocks need not be filled with mastic to their whole depth. In this case, they are to be placed side by side, so as to touch one another completely. Fine sand is to be worked into the joints by a knife, to within $1\frac{1}{4}$ inches of the surface, and they are then to be filled in with mastic as before. Such paving should, however, be six inches thick.

Applications of this mode of Construction.—Its Advantages and Disadvantages.—The viaduct, of three arches, each of about 13 feet 10 inches openings, built near Saumur, on the Tours and Nantes Railway, for the National Road, No. 138, has been paved with blocks of the nature first described. The blocks are about $4\frac{1}{2}$ inches deep, and each of them is formed by the assembling together of nine long stones in three rows of about 4 inches wide. They were placed on a bed of sand about $\frac{5}{8}$-inch thick, and laid immediately upon the masonry. No mortar rendering was executed on the top of the extrados of the arches; so that the species of road covering of this bridge is only $5\frac{1}{8}$ inches thick. As the depth of the arch at the key is only 1 foot $5\frac{3}{4}$ inches, the total thickness from the intrados to the surface of the roadway is only 1 foot $10\frac{7}{8}$ inches, a result which could not otherwise be attained unless wood or iron beams had been used. The immediate vicinity of the bridge over the Loire imposed upon the engineer the necessity of not altering the level of the paving, and limited the height of the arch.

It would have been possible to have attained the object proposed by substituting, instead of this paving, a bituminous macadam laid upon an ordinary broken stone road; but it was feared that the masonry of the bridge would have been injured by the action of the rolling traffic during the consolidation of the form, and the less hazardous course described was adopted. The road was opened for traffic in 1846, and has preserved the viaduct from all infiltrations. Its success has been remarkable, and even after three years circulation it presented a perfectly even surface.

To obtain this result, however, it has been necessary to choose stones of very great hardness, whose rate of wear was very small, and, consequently, nearly even. Indeed, it must be evident, that as the stones which form this description of roadway are bound together by the mastic to a considerable depth, their displacement would be long and costly. Yet any depressions arising from inequalities in the wear must be repaired in this manner, for the connexion between all the stones prevents the application of ordinary modes of repair. The repairs of the subterranean

works of a town would, from the same cause, become of very difficult execution.

This description of roadway has the additional disadvantage of being very expensive; it cost at Saumur about from 12 to 15 francs per metre superficial, or from 1*s.* to 1*s.* 3*d.* per foot. The bituminous macadam should then be used, unless very exceptional circumstances should call for the adoption of some particular description of paving.

A modification of this system was tried, in which the joints were only filled in with mastic to a depth of 1½ inches; but its success appears to have been doubtful, nor does any other result appear to have been attained than that of rendering the execution of the paving more complicated and more expensive.

(To be Continued.)

On the Progress of the Wave System of Naval Architecture. *By* JOHN SCOTT RUSSELL.*

The great interest taken by the British Association in this system at its origin, and the numerous experiments which they instituted for the purpose of establishing its truth, and of diffusing information upon it, have rendered it my duty to place on record each year those steps of progress which it has made in affecting the character of practical construction, and especially in giving to steam vessels increased speed, not only without a sacrifice of other good qualties, but with an increase of the sea-going requisites and mercantile points of excellence. At the last meeting I laid before this section an account of the successful introduction of the wave system into practice on several steam vessels and sailing vessels at Rio Janeiro, by Mr. Dodgson, who had found the system in all respects successful, and that the vessels he had built on it had beaten their competitors on the old system. Since that time a treatise on naval architecture, published in America, has been transmitted to this country. It contains drawings of many of the most recent and celebrated vessels constructed in that country. The author of that treatise does not hesitate to avow frankly the general adoption of the principles of the wave system, by the builders of the best and fastest vessels in America. He gives accurate drawings, which are evidently made in accordance with it.

He quotes experiments as high as twenty-four miles an hour, which speed has been attained by its use. He unhesitatingly declares his own implicit belief in the system and entire adoption of it. In our own country the most eminent builders of fast steam vessels continue to adopt the most prominent characteristics of the wave system, viz., hollow water lines for the bow, much fuller water lines abaft than forward—the greatest breadth nearer the stern than the bow. I am not sure how far the builders of these vessels would wish it to be understood that they do adopt the wave system; and I shall, therefore, confine my further observations to vessels which have been built under my own immediate care. During the last year an opportunity has presented itself of obtaining one of the most decided practical experiments on a larger scale regarding the excellence of the new form for steam vessels. It is very rare that in ordinary practice one can obtain an experiment which will exactly deter-

* From the London Architect for August, 1851.

mine the relative merits of two different forms of ships; because there is generally some diversity in the application of the power or in the circumstances, as, for example, a difference between the excellence of the engines, which affect materially the result, and which is quite independent of the qualities of the ship.

But if one could get an experiment of the following nature. If one could take a steam engine of a given power, and supply it with as much steam of a given pressure as the engines could use; and a given pair of paddle-wheels, so as to apply that power in exactly the same way in both cases, and having first tried these engines in a ship built on the old system, if one could then simply take these engines out of that vessel and place them in one built on the new system, of equal or greater tonnage, then if the new vessel, being tried in similar circumstances, should be found to excel the old one, we should have a result in a practical form which could not fail to be satisfactory. Such is the experiment which has just been obtained on a sufficiently large scale to be entirely conclusive. A pair of marine engines of 220 horse power had been working on board a wooden steam vessel of 450 tons, being a proportion of one horse power to two tons nearly. The beam of the vessel was 24 feet, and her draft of water 9 feet. This vessel was built on the old system, according to his own plan, by one of the most eminent builders of steam vessels.

This vessel was placed on the line between London and Antwerp, and realized a maximum speed of ten miles an hour. These engines, with the same paddle wheels, were then taken out of the vessel, and were placed in a new iron vessel, built upon the wave system, by Messrs. Robinson and myself. This vessel was of larger beam and greater length of body than the former, being 570 tons, with 25 feet beam and 9 feet draft. The experiment has now been tried with the same old engines, but repaired and furnished with new boilers capable of supplying the full amount of steam to the engines. The result has been conclusive. The vessel has not been made unusually sharp or fine, but, on the contrary, is a capacious sea-going vessel, with capacity for 150 tons of cargo more than the former vessel. The new form of vessel with the old engines has attained a maximum speed of 15 miles an hour—being a clear gain of speed of five miles an hour. It is important to observe, that where speed is obtained by improved shape of vessel, it is obtained at the least possible first cost and greatest economy in daily use. I have next to report during the past year the first application of the wave system to the construction of war steamers. It had long been supposed that owing to the fineness of water lines of the bows of vessels built on the wave system, it would not be possible for them to carry the same amount of heavy ordnance calculated to fire in a line with the keel as in vessels of the ordinary construction. Even in these it is difficult to carry so large an armament in proportion to tonnage as desirable. It has been repeatedly urged as an objection to the wave formed vessels, that they would not carry a heavy armament. During last year, however, two war steamers have been constructed for a foreign government, of 500 tons, and 160 horse power, upon the wave system, by Messrs Robinson and Russell. They have been fully armed, stored with provisions and fuel,

and tried by a naval commissiom at sea; and have been accepted as having fulfilled the following conditions of their construction, viz., that they were to carry double the armament of any war steamer of the same tonnage and power in her Majesty's navy, and go two knots an hour faster than any vessel in her Majesty's navy. Dimensions, power, armament, &c.; Vessels 165 feet long, 26 feet wide, 500 tons; engines, 48 inches diameter, 4 ft. 6 in. stroke, 160 horse power; armament, four 8 inch guns, 9 ft. 6 in. long; ammunition, 100 rounds; fuel, 2000 miles steaming; speed, 15 miles an hour light, 13 miles an hour loaded. I have last to report the trials during the past winter of a yacht, the *Titania*, built for Robert Stephenson, Esq., the eminent engineer, who had confidence enough in the wave system to give it a fair trial on a sailing schooner which he sent round during last winter by the Bay of Biscay to Alexandria, and in which he encountered severe hurricanes in the Mediterranean. The results of the experiments are, that the war vessel has been found to be in every respect, a good sea boat; and contrary to the expectations of many who fancied that the fine bows of wave vessels were only good for fair weather sailing, it has turned out that while in light airs and smooth water, vessels of a lighter build and larger sails may pass the *Titania*, yet that, in any weather stronger than a light breeze, she has beat every vessel she has encountered, including yachts of high reputation and larger tonnage. It thus appears that during 1850–51, very considerable progress has been made in the introduction of the wave principle into practical use.

For the Journal of the Franklin Institute.

Rule for Calculating the Weight that can be safely trusted upon a Pile which is driven for the Foundation of a Heavy Structure. By John Sanders, *Brev. Maj. U. S. Eng.*

A simple empirical rule, derived from an extensive series of experiments in pile driving, made in establishing the foundation for Fort Delaware, will doubtless prove acceptable to such constructors and builders as may have to resort to the use of piles, without having an opportunity of making similar researches. I believe that full confidence may be placed in the correctness of this rule, but I am not at present prepared to offer a statement of the facts and theory upon which it is founded.

Suppose a pile to be driven, until it meets such an uniform resistance as is indicated by slight and nearly equal penetrations, for several successive blows of the ram; and that this is done with a heavy ram, (its weight at least exceeding that of the pile,) made to fall from such a height that the force of its blow will not be spent in merely overcoming the inertion of the pile, but at the same time not from so great a height as to generate a force which would expend itself in crushing the fibres of the head of the pile. In such a case it will be found that the pile will safely bear, without danger of further subsidence, "*as many times the weight of the ram, as the distance which the pile is sunk the last blow, is contained in the distance which the ram falls in making that blow, divided by eight.*" For example, let us take a practical case in which the ram weighs one ton

and falls six feet, and in which the pile is sunk half an inch by the last blow; then as half an inch is contained 144 times in 72 inches, the height the ram falls, if we divide 144 by 8, the quotient obtained, 18, gives the number of tons which may be built with perfect safety, in the form of a wall, upon such a pile.

Fort Delaware, September 27th, 1851.

AMERICAN PATENTS.

List of American Patents which issued from September, 16, *to October* 7, 1851, (*inclusive*,) *with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

29. For an *Improvement in the Manufacture of Iron;* Samuel T. Jones, City of New York, September 16; patented in England July 23, 1850.

"My invention consists in the application of the ore called Franklinite, to the preparation or manufacture of iron from its ores, or in the finery, boiling, puddling, &c., of crude or pig iron."

Claim.—"Having thus fully described the nature of my invention, what I claim as new therein is, the application of Franklinite to the improvement of iron, in the process of reduction from its ores, and in the finery or puddling of crude or pig iron, according to the methods as above described."

30. For an *Improvement in Bedsteads;* Ira Russell, Dedham, Massachusetts, September 16.

Claim.—"What I claim as my improvement is, the suspension spring or strip, the thrust spring, and the spring between them, as combined or applied together, and to the bedstead and slats imposed upon them, substantially as herein before specified."

31. For an *Improvement in Railroad Car Coupling;* George Winters, Portsmouth, Pennsylvania, September 16.

"The nature of my invention is a useful improvement in the shape and construction of a car platform, in combination with a jointed self-acting pin and stationary pin, for coupling and disconnecting cars."

Claim.—"What I claim as my invention is, the shape and construction of the improved car platform, in combination with the jointed self-acting pin, stationary pin, and grooved half coupling, all as herein described, for the purpose of coupling and disconnecting cars."

32. For an *Improvement in Machines for Breaking Hemp and Flax, and Reducing the Length of the Fibres;* James S. Treat and Stephen Randall, Voluntown, Connecticut, September 16.

"The nature of our invention consists in an entirely new method of reducing flax, either in the straw or otherwise, to suitable length of staple, separating the woody substance from the fibres, by one operation, which we accomplish by means of a series of grooved or otherwise graduated rollers, so arranged and geared, decreasing in size and varying in speed, as to separate the fibres, and prepare it for the carding and spinning machinery, whether the machinery be constructed as hereinafter described and represented, or in any other manner substantially the same in principle and operation, whereby the same result is accomplished."

Claim.—"Having thus fully described our invention, what we claim therein is, the art or method of separating the fibres of flax, hemp, &c., from the boon, and reducing them to suitable length of staple, to be used on cotton, woolen, and other machinery, by the use of combined sets of grooved and graduated rollers, or their equivalents, operating in the manner and for the purpose herein fully set forth and represented."

33. For a *Gauge for Indicating Pressure of Steam, &c.;* George Faber, Canton, Ohio, September 16.

"This invention is for the purpose of ascertaining the degree of pressure to which elastic fluids are subjected under certain circumstances; as, for example, in the generation of steam in ordinary steam boilers; and is chiefly intended for application to such boilers. The principle upon which the invention is based, is the power produced by a free current of an elastic fluid impinging upon an inelastic substance, as a disk of metal, &c., the velocity or pressure being ascertained by the distance the disk has been moved by the force of the current."

Claim.—"What I claim as my invention is, combining with the steam tube, the disk and spring, so arranged that the force of the current of steam impinging upon said disk, can be ascertained by the extent to which the spring is expanded, and thus can be known the comparative pressure in the boiler or other vessel, necessary to give the required velocity to the current, to produce different degrees of expansion of the spring, substantially as herein set forth."

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34. For an *Improvement in Apparatus for Draining Sugar;* Smith Gardner, City of New York, September 16.

"The nature of my invention consists in arranging one or more series of pans, with their bottoms perforated or made of wire gauze, and each provided with a pan or receiver below, to catch the molasses; and provided with an aperture for the passage of the current of air; the whole being otherwise made air-tight, so that the current of air forced into the first shall, in producing the required effect, pass to the second, to produce a like effect there; thence to the third, and so on throughout the series, and thence in like manner through other series, if desired."

Claim.—"What I claim as my invention is, combining two or more straining pans with molasses or receiving vessels below each, substantially as described; the said pans being provided with a discharge pipe or tube, substantially as described, so that the current of air shall pass from the lower part of the first to the upper part of the next, through the series, and so arranged as to retain the molasses or other liquid parts; and this combination I claim, whether the said succession of pans be used in one or more series, as described."

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35. For an *Improvement in Stone Drilling Machines;* Henry Goulding, Boston, Massachusetts, September 16.

Claim.—"Having thus described my new drilling machine, I shall state my claim as follows: What I claim as my invention is, 1st, A power-drilling machine, in which the drill is driven by a vibrating hammer, operated substantially as herein above described.

"2d, I claim stopping the "feeding forward" of the sliding frame and drill, when the latter does not penetrate the rock sufficiently, or to the usual depth, at each blow, by keeping the pawl out of the feeding ratchet, excepting when the drill goes in the requisite length, by means of the combination of the forked vertical lever, connected with the drill shaft, the horizontal lever, and the spiral spring, operating substantially as herein above set forth.

"I also claim, drawing the edge of the drill away from the bottom of the hole, when the tool is being turned, by means of the inclined claw or fork, operating with a collar on said drill, substantially as herein above described."

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36. For an *Improvement in Machines for Dressing Millstones;* Erastus W. Hazard, Binghampton, and Charles H. Jenner, Rochester, New York, September 16.

"Our invention consists in combining with the lever which operates the feed hand or hands, and which receives motion from a rotating cam or tappet, a weighted lever, or the equivalent thereof, which falls by its weight the moment the lever is carried back to give one feed motion, so that the end thereof shall act as a stop to arrest the feed motion, that the cutter may continue to strike in the same place, until the attendant lifts up the lever to permit the feed motion to continue."

Claim.—"We claim, in combination with the feed lever operated by the cam to work the feed bands, the employment of a weighted stop lever, or the equivalent thereof, acting

in the notch of the lever, substantially as described, which said stop shall be self-acting, to stop the feed motion, that the cuts may continue in the same place, until the feed motion is re-started, and thus insure the cutting of the stone to the required depth, whatever may be the texture thereof, as described."

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37. For an *Improvement in Processes of Making Bronze Powder;* Leopold Brandeis, City of New York, September 16.

"The nature of my invention consists in producing the powder, by rolling it between steel or iron tempered rollers, instead of the old producing (kept secret), to beat the metal to dutch leaf, and grinding it, to give it a bright and brilliant surface, by covering the bronze with soap, instead of grease and oil, and polishing the surface by application of polished rollers."

Claim.—"What I claim as my invention is, making metallic bronze powder of copper, tin, spelter, or their alloys, by running them through iron or steel rollers, substantially as described. Also, the application and manner of application of soap, to make the bronze bright, and brilliant, and durable."

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38. For an *Improvement in Stoves;* Gardner Chilson, Boston, Massachusetts, September 16.

Claim.—"What I claim as my invention is, forming the tapering radiator, produced by extending the fire chamber, as above set forth, in branches arranged with their centre lines parallel to each other, or nearly so, and connected by arches, substantially in the manner above set forth."

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39. For an *Improved Bench Vice;* N. F. Cone, Kingsville, Ohio, September 16.

Claim.—"What I claim as my invention is, the combination of the latch pin, the ratch bar acted upon by a spring that constantly tends to disengage it from the latch pin, and the foot lever, with the movable jaw of a vise; these several parts being constructed, arranged, and operating as herein set forth."

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40. For an *Improvement in Weavers' Temples;* Arnold Jillson, Woonsocket, Rhode Island, September 16.

Claim.—"What I claim as my invention is, connecting the movable jaw to its point of suspension, by an arm, or equivalent, in such a manner that the point of suspension will be nearer the middle of the cloth than its other extremity, which extends out towards or beyond the selvedge at such an angle, that the jaws of the temple will be released by the cloth, as it is spread by the action of the reed upon the warp, when it strikes up a thread of weft, and closed by the contraction of the cloth, caused by its own elasticity, as the reed leaves it; so that the cloth, by its own action, is released when the reed advances, and is griped and held as it recedes; thereby dispensing with the strong spring, wedge, and other devices, heretofore used for operating the jaws of temples."

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41. For an *Improvement in Leather Splitting Machines;* Alpha Richardson, North Enfield, New Hampshire, September 16.

Claim.—"Having thus described my improved leather splitting machine, I shall state my claim as follows:

"1st, Making the gauge roller of a leather splitting machine, with the sectional tubes or friction rollers, to be placed on each end thereof, substantially as herein above set forth, and for the purpose specified.

"2d, I claim combining with the ordinary cast iron spring plate of a leather splitting machine, a cast steel spring plate, forming a double lip spring plate, and fitted thereon, so as to be adjustable horizontally, as herein above set forth, and so that the front edge of the lower or cast iron plate may project under the edge of the knife, and hold up the split, as herein above set forth."

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42. For an *Improvement in Fastenings for Last Blocks;* Levi R. Rockwood, Assignor to Joseph L. Woodward, Upton, Massachusetts, September 16.

Claim.—"Having thus described my improvement, what I claim as my invention is,

fastening the block to a boot or shoe last, by a hasp on said block, in combination with a spring attached to the last, as herein above described, or in any other manner substantially the same."

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43. For an *Improvement in Waste Pickers;* Charles G. Sargent and Robert Thompson, Lowell, Massachusetts, September 16.

"The object of our improved machine is, to separate or reduce yarn, cloth, woolen, or cotton rags, or waste, to their original or primary condition of fibre, and to straighten the fibres out."

Claim.—"Having thus described our improved machine, what we claim as our invention is, the use of a blast of steam or air, passing into and out of the hollow shell, as herein above specified, so as to blow the ends or fibres of the material out, in order to enable the teeth of the picking cylinder to engage with them."

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44. For an *Improvement in Machines for Printing House Paper;* Milton D. Whipple, Assignor to The Essex Company, Lowell, Massachusetts, September 16.

"The great object which is attained by my machinery is, preserving "the register" (so to speak) in printing house paper, so that in printing several colors with different blocks, the patterns shall appositely fit each other, or be printed in accurate relative positions."

Claim.—"Having thus described my improvements in house paper printing machinery, what I claim as my invention is, the use of two sets of spur clamps, one set being sliding and feeding clamps, and the other set being stationary and holding clamps; and the two sets having a connected operation, so that one set shall be open when the other set is closed, all as herein above set forth.

"I also claim the mode herein above described, for supplying the coloring fluid to the patterns; that is, by means of a cloth band, alternately drawn forward from the vat, over an elastic bed, on which the platen descends, and then back again, through the color in the said vat, all as herein above set forth.

"I also claim, giving the second or double application of the color to the patterns, for each impression, by suddenly lowering the elastic bed, after the first touch of the patterns on the cloth band, and then raising it again for the second touch, substantially in the manner herein above set forth."

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45. For an *Improvement in Churns;* George B. Clarke, Leonardsville, New York, September 23.

Claim.—"1st, I claim the employment of a revolving vessel, containing the cream or milk, with or without cleats, constructed either plain or with pins, or having any other suitable internal projections, and operating in combination with a toothed or plain stationary cross bar, removably or permanently secured to the fixed axles, and situated in the space forming the upper half of the vessel, at any desired distance from the centre thereof.

"2d, I likewise claim the employment of a temporary cylinder and tubes, in combination with the revolving vessel and cross bar, for cooling, or warming, and agitating the milk, by its precipitation thereon, as caused by the circular motion conveyed to the milk, and interrupting or arresting effect produced, substantially as shown and described."

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46. For *Improvements in Machines for Scutching and Hackling Hemp and Flax;* Owen W. Grimes, Paducah, Kentucky, September 23.

"The nature of my invention consists in the manner of throwing the teeth in and out of the drum, with which they revolve, to any desired distance, while the machine is in operation, so as to give more or less hold on the hemp or other material, or drawing them entirely within the drum, when the material becomes entangled, and liable to choke or break up the machine; and also the method of allowing the teeth, when out, to fall back, or yield sufficiently far to allow the material to slip over them, when too great a strain is suddenly brought upon them, and recovering their proper position again after passing said obstruction."

Claim.—"Having thus fully described my invention, what I claim therein as new is, the method herein described, or any other means essentially the same, of throwing the teeth in and out of the cylinder or drum, at pleasure, whilst in motion, so as to present a

greater or less length of teeth to the hemp, or drawing them entirely within the cylinder, in case the hemp should become entangled, and likely to break up the machine.

"2d, I claim, in combination with the bar holding the teeth, the spiral spring, for allowing said bar to yield to knots or other obstructions, and for drawing back into proper position the said bar, after it is released from said obstruction.

3d, I claim, in combination with the bar and teeth arranged as herein described, the adjustable guides, for setting the teeth at such angle as will give them more or less hold upon the hemp, as herein fully described and represented."

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47. For *Improvements in Machines for Stripping Seed from Broom Corn;* L. D. Grosvenor, South Groton, Massachusetts, September 23.

Claim.—"Having thus described the nature and operation of my invention, what I claim as new is, the endless bearded belt, constructed of any proper material, and having "lugs" or spikes as described, in combination with the comb rollers, set diagonally upon the frame, in the manner and for the purposes substantially as set forth."

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48. For an *Improvement in Lath Machines;* William Merrell, Randolph, Ohio, September 23.

"The nature of my invention consists in a long horizontal frame, having a rotary saw hung upon a spindle placed transversely upon it, near its centre; upon the top of the front part of the frame a suitable table or bed is provided, for the purpose of receiving the slab or stuff from which the laths are to be cut, which is fed to the saw by feed rollers; near the top end of the frame is a contrivance (to be hereinafter described) for throwing out each lath immediately after it is cut off, and throwing down the slab or stuff to a series of rollers, which return it to the bottom end of the frame, where the attendant stands to receive it, and place it again on the table for another cut; the saw has a cutter attached to and rotating with it, for the purpose of planing, or giving any required bevel or form to the edge of the lath, at the same time that it is being cut off."

Claim.—"Having thus fully described my invention for sawing laths, I desire it to be understood, that I do not claim mounting a rotary cutter on the same spindle of the rotary saw, as herein described; nor do I claim the returning table, consisting of a series of rollers, arranged and operated in the manner described. But what I do claim is, the director and carrying belt, in combination with the apparatus for registering, substantially such as described, for delivering bundles ready counted.

"I also claim the rounded surface of the receiving table, in conjunction with the bent form of the strip, as represented in fig. 2, at *k*, which effects in the simplest manner the delivery on the returning rollers of the unsawed slab to the attendant for another cut."

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49. For an *Improvement in Easy Chairs for Invalids, &c.;* Patrick O'Neil, Brooklyn, New York, September 23.

Claim.—"Having described the construction and uses of my adjustable combination chair, what I claim therein as new is, the manner of combining the jointed chair with the jointed ottomans, whereby the whole is made to subserve the several purposes herein before described, and illustrated in the drawings.

"I also claim furnishing the back of the chair with an additional joint, whereby the back of the chair is rendered susceptible of such adjustment as to form a support to the spine of the occupant of the chair, as described and shown in the drawings.

"I likewise claim the employment of the triple jointed hinges, in combination with the spiral springs, for securing the flexible bolster, by which it is steadied and retained in its proper position, when expanded and contracted, as set forth."

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50. For an *Improvement in Ventilating Ships;* Amos J. Sexton, Brooklyn, New York, and William Ennis, City of New York, September 23.

Claim.—"We do not claim to have invented either the caboose, water back ventiducts, or valves, although we do not know of the several parts referred to having been used for the purpose described; but what we do claim as our joint invention is, the combination and application of the caboose, water back ventiducts and valves, in connexion with our

water surface and the cowl and vane, for the introduction of pure air and the expelling of impure air, as described, and for the purpose herein before mentioned."

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51. For an *Improvement in Machinery for Threading Wood Screws, and Feed Apparatus therefor;* Thomas J. Sloan, City of New York, September 23.

Claim.—"What I claim as my invention is, the employment of two cams in combination, substantially as described, for the purpose of operating the fingers which supply and present the blanks to the griping jaws, as described.

"I also claim the employment of one cutter to form thread on the conical point, when combined and operating simultaneously with a second cutter, for forming the thread on the main part of the shank, substantially as described and for the end specified, provided the motion of one of the cutters is extended into the track of the other, to ensure the making of the thread on the conical point a continuation of the thread on the main part of the shank."

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52. For an *Engine, in which Compressed Air or other Gas, Heated and Expanded by Admixture therewith of a Heated Fluid, is used as a Motive Agent;* William Mt. Storm, City of New York, September 23.

Claim.—"Having thus fully described the nature of my invention, what I claim is, actuating an engine, such as are now usually driven by steam, or of any convenient form, by means of a measured or detailed quantity of air, previously compressed, and having had its tension due to such compression, highly increased and augmented, by the jetting or flashing into or commixture with it of a measured or detailed quantity of a "medium," or, in other words, of a heated liquid, as water, or a vapor (simple or super-heated) as steam; said jetting of the steam into the air, (or vice versa, the air into the steam, which I claim as equivalent,) and their commixture, being effected in a vessel or vessels disconnected previous to and during that process, or at least prior to its final consummation, from the reservoir or main source of compressed air, and from that of the steam, &c., and each separate and distinct charge or detailed quantity of compressed air, heated by its corresponding charge or detailed quantity of steam, being allowed to act upon the piston, or its equivalent, prior to the admission or introduction of another charge of air and steam into the vessel or vessels in which their commixture is effected; the whole operation being carried out by means of mechanism, in substance such as here represented, or any more fitting mechanism that shall effect the same in the manner here claimed."

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53. For an *Improvement in Shoe Latchets;* Isaac Banister, Newark, New Jersey, September 23.

"The nature of my invention consists in attaching to a flap, which passes over the instep, and is connected to one of the quarters of a shoe, a thin flexible plate or latch, which is curved at its front end, for fitting into a socket or eyelet, secured between the lining and upper leather of the vamp of a shoe, and at the other end projects beyond the said flap a sufficient distance to enable it to be passed under a catch or hook, which is secured to the opposite quarter of the shoe, and serves by its action on the latch, to confine the shoe firmly to the foot."

Claim.—"What I claim as my invention is, the confining a shoe to the foot by means of a flexible latch, secured to one portion of the said shoe, acting in conjunction with a socket or eyelet and a catch or hook, secured to other parts of the shoe, and operating substantially in the manner herein set forth."

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54. For an *Improvement in the Churn and Butter Worker;* Asa Willard, Boston, Massachusetts, September 23.

Claim.—"I claim the combination of one or more fluted rollers, with one or more floats, to operate so as not only to aid in the process of separating the butter from the cream, but afterwards, and when the motion of the dasher is reversed, to throw into ridges the butter spread on the bottom of the floats.

"And I claim the improvement of giving a longitudinal hollow or curve to the external surface of each float, for the purpose of gathering the spread butter towards its middle, and preventing the butter from adhering to the ends of the reservoir, as specified."

55. For an *Improvement in Piano Fortes;* Louis H. Brown, Boston, Massachusetts, September 23.

Claim.—"Having thus described my improvements, what I claim as my invention is, 1st, arranging the sounding board in a springing form, and supporting its back on a straining lever, made to bear with more or less force against it, in the manner and for the purpose herein above specified.

"2d, I claim the combination of the short subsidiary iron frame, having a rectangular socket on its front rail, with the long main iron frame, having a wooden block on the under side of its front rail, which fits and is glued into the aforesaid socket, as herein before set forth.

"3d, I claim casting the bridge of the long iron frame with curved brackets, so as to have it raised above the level of the bottom of the front rail of said frame, and permit the strings to be strained or strung under the same, as herein above explained.

"4th, I claim easing the escapement of the fly of the jack from under the centre block of the hammer, by means of a spring, combined with said block and the stem of the hammer, as herein above stated.

"5th, I claim arranging the back catch on a lever, having a fulcrum in the jack, and arranged so as to cause the catch to follow the hammer in a stroke of the same, and cause it to repeat the stroke or note, if desired, when the fly of the jack fails to operate, so as to effect said second stroke.

"6th, I claim using a piece of gutta percha on the top of the hammer head, in lieu of some of the layers of leather, in the manner and for the purpose specified."

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56. For an *Improvement in Letter Stamps;* Benjamin Chambers, Washington, D. C., September 23.

"The purpose of my invention is to furnish a stamp, having a simple and ready mode of discharging the movable letters and figures containing the date of the stamp, while preserving the integrity of the cylindrical metallic or other block containing the fixed letters, and avoiding the cutting away and weakening of the handles."

Claim.—"I do not claim punching out types from a cavity by a follower; but what I do claim as my invention is, so making and operating the detruding rods or followers of a letter stamp, as to act wholly within the body of the stamp block, whereby I avoid cutting away the handle, and the weakening which would be caused thereby.

"I also claim making the detruding rod, wing, and thumb slide in a single piece, whereby I greatly economize the labor of making this part of the stamp, as herein set forth."

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57. For an *Improvement in Attaching Cutter Bars to Harvesters;* John H. Manny, Waddain's Grove, Illinois, September 23.

Claim.—"What I claim as my invention is, hanging the cutter bar of a reaping machine to the side of a triangular frame, in such manner that neither extremity of the cutter shall be liable to sag below the other extremity, as herein set forth."

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58. For an *Improvement in Printing Presses;* Jacob Worms, Paris, France, Assignor to Jacob Phalen, City of New York, September 23; patented in France (in part) May 19, 1849, and (in part) September 27, 1849.

"My invention may be summarily designated as the printing with rapidity, either in ink or colors, by the aid of certain apparatus herein described, a continuous sheet of paper or stuff, on one or both sides, and of cutting and folding the same."

Claim.—"Having now described fully the nature of my invention and its application, I will here observe, that engraved or sunken cylinders have been already used for the printing of woven fabrics, but these are very expensive to manufacture, compared with the cylinders prepared as I have described. I wish it also to be understood, that in the apparatus described, I do not confine myself to the exact details herein set forth, for these must necessarily vary with the size of the matter to be printed, or with the greater or less rapidity with which the movements are to be executed. It must also be understood, that I do not claim, individually or separately, any of the parts of the apparatus or machinery.

"But what I do claim as my invention is, 1st, In combination with the ink troughs, E,

and printing cylinders, A, the arrangement of the cam cylinders, D, reciprocating cylinders, K, (operated by the levers, J,) and L, (operated by the levers, M,) and cylinders, G and N, for receiving, carrying, and distributing the ink from the said trough to the said cylinders.

"2d, I claim, in combination with the printing cylinders, the cylinders, O P, provided with a spring knife or saw, operated by cams, and also with alternate ribs or projections and grooves, for the purpose of nearly severing the filaments of the paper, as it passes through between said rollers, and for the purpose also of creasing the paper, for the more easily folding of it.

"3d, I claim, in combination with the partially cutting and creasing cylinders, O P, the different sized cylinders, C D, geared together, for the purpose of tearing apart the partially cut paper—the cylinders, C, holding, and the increased motion of the cylinders, D, at their periphery (they being the larger) drawing the paper sufficiently to separate it.

"4th, I claim, in combination with the separating cylinders, C D, the tunnel, G, for guiding, and the wheel, E, divided into a suitable number of compartments, for receiving the sheets as they are delivered from the machine; the whole being constructed substantially as herein described, and for the purposes fully set forth."

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59. *For Blind or Shutter Fasteners;* Washburn Race, Seneca Falls, New York, September 23.

Claim.—"What I claim as my invention is, the combination of the fast and free hooks with the inner plate, the same being arranged as herein set forth, in such manner that the fast hook forms the pivot for the free one, and the two are connected to the inner plate in such manner that the movement, breakage, or removal of the free hook does not affect the security of the fastening, while at the same time the two hooks are secured to the inner plate, by the fastening of the latter to the shutter."

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60. For an *Improvement in Hand Stamps;* Stephen P. Ruggles, Boston, Massachusetts, September 23.

"The nature of my invention consists in so constructing a hand stamp, that by moving it in the arc of a circle, such as would be naturally made by the rising and falling of the arm, it will still come down upon the paper at all points of its surface, although it may strike at an angle with the plane upon which the material to be stamped is placed, and at all times make a fair and perfect impression, whether moved in a perpendicular or oblique line to the same."

Claim.—"Having thus fully described the nature of my invention, what I claim therein as new is, securing the plate of a hand stamp to the shank or handle, by means of a universal ball and socket, or other joint, so as to allow the stamp to make a fair impression, at whatever angle it may strike the material to be stamped, as herein fully set forth and explained."

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61. For an *Improvement in Piano Fortes;* Timothy Gilbert, Boston, Massachusetts, September 30.

Claim.—"What I claim as my invention is, the combination of the return screw and button, or equivalent contrivance or contrivances, with the hammer and fly, and its retractive spring, so as to operate in manner and in connexion with the same and other parts, substantially as herein described."

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62. For an *Improvement in Weavers' Shuttles;* Laroy Litchfield, South Bridge, Massachusetts, September 30.

"My invention consists in forming the spindle, the spring, and the catch, all in one piece, for the purpose of cheapening the construction, and lessening the liability to get out of repair; and in providing the shuttle with a pin, inserted transversely or parallel to the pin on which the spindle plays, for the purpose of throwing back the spring and catch, and releasing the bobbin when the spindle is turned up from the mouth of the shuttle."

Claim.—"What I claim as my invention is, making the spindle and spring both in one piece, by extending the spindle behind the hole, for the pin that fastens it into the shuttle, and reducing it to a proper thickness, and bending it to form the spring required

to hold the spindle in its proper positions in the shuttle, either with or without the catch on the end of the spring, in combination with the pin or its equivalent, against which the spring acts, to hold the spindle in the different positions required, substantially as described, thereby avoiding the inconvenience arising from the loosening of the screw which holds the spring in other shuttles, and saving the additional labor required to fit it in, when the spring is made separate from the spindle."

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63 For an *Improvement in Weighing Carts;* Norman B. Livingston, Portland, Indiana, September 30.

Claim.—"Having thus fully, clearly, and exactly described the nature, construction, and operation of my improved weighing car, what I claim therein as new, is, the construction and arrangement, substantially as described, by which a weighing apparatus is capacitated for easy removal from place to place, by the adaptation to each other of the containing and weighing apparatus and of the running gear; that is to say, by making the fulcra for the lever or weighing beam upon the axle near the wheel; the arm, with its sliding weight, lying upon the pole or tongue, and the axle affording, by its bent form, free access to the contents of the box, when discharged, by means of the valve."

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64. For an *Improvement in Self Acting Presses;* Wm. Moore, Belville, Ohio, September 30.

Claim.—"Having thus described the construction of my press, I desire it to be understood that I do not claim either the cams, or the temple joint, when used singly; but what I claim as new is, the combination of the eccentric cams rolling on each other, so as to avoid friction, in connexion with the braces, or temple joint, as above described, for the purpose and substantially in the manner aforesaid."

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65. For an *Improvement in Saws for Sawing and Smoothing Boards;* Geo. F. Woolston, District of Orangeburg, South Carolina, September 30.

Claim.—"I claim for the purposes above set forth, forming and arranging teeth of saws substantially as herein described."

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66. For an *Improvement in Instruments for the Cure of Stammering;* Robert Bates, Philadelphia, Pennsylvania, September 30.

"The nature of my invention consists in the employment of a tube in the mouth, for the passage of air from the mouth, when the muscles that close the orifice of the mouth, and stop the egress of air, in speaking, are suddenly contracted by spasmodic action; and in the employment of a strap around the throat, provided with a spring pad, regulated by a screw, which pad presses against the throat, and keeps the glottis or larynx of the throat open, thereby allowing a free passage of air through the throat and mouth, from the lungs; the arrest of which air, by the spasmodic action of the throat and mouth, causes stammering, and its escape by means of my instrument, cures the spasmodic action, and consequently cures stammering."

Claim.—"Having thus fully described my instruments for the cure of stammering, and their application and method of use, what I claim as my invention is, 1st, the employment of a tube in the mouth, which will admit of speaking, and of the passage of air, when either the tongue or lips would prevent the passage of air, substantially as herein above set forth.

"2d, The employment of the adjustable spring pad, substantially as herein above set forth.

"3d, The joint employment of the mouth tube and the adjustable spring pad, at the same time curing the guttural, lingual, and labial disease of stammering, substantially as herein above set forth."

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67. For a *Machine for Making Wheel Tires;* Maria Vaughn, Greenbush, New York, Administratrix of Joseph C. Vaughn, deceased, Assignor to James C. Bell, Greenbush, New York, and Robert Christie, Jr., of the City of New York, September 30.

Claim.—"What I desire to claim is, the combination of the upper and lower dies, with the welders, receiving motion from wedges attached to the upper and falling die;

the whole acting to shape a tire on all parts of its surface at the same time, substantially as described in the within specification."

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68. For an *Improved Maze Lock;* Thomas Nicholson, Falmouth, Virginia, September 30

Claim.—"What I claim as my invention is, the disk with its concentric and radial passages, or their equivalents, in combination with the bolt end, operated substantially in the manner and for the purposes herein described."

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69. For a *Machine for Arranging Screw Blanks and Articles of a Similar Character;* Thomas J. Sloan, City of New York, September 30.

"The nature of my invention consists in combining two inclined stationary ways with a movable trough, formed of oppositely inclined surfaces, provided with a pin or pins, or their equivalents, that pass between the ways, the lower end of the said ways extending down to or below the surface of the said trough, so that as the said trough, with its pin or pins, is set in motion towards the ways, the screws, or other articles to be arranged and delivered, will be carried on to the ways, and such of them as are found with their shanks between the ways, will be carried or forced up the inclined ways to the delivery end."

Claim.—"Having thus described the principle or mode of operation of my said invention, and the manner of constructing and using the same, I wish it to be distinctly understood, that I do not limit myself to the precise mode of construction and arrangement specified, as these may be varied, without changing the character of my invention. What I claim as new is, the combination of the inclined ways, substantially such as herein described, with a trough, substantially such as described, and provided with a pin or pins, or their equivalent, as described, so that by the motion of the trough towards the ways, or vice versa, the screws or other articles will be forced up the inclined ways, hanging by their heads, as described."

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70. For an *Improvement in Plotting Scales;* Lemuel H. Parsons, Lambertville, New Jersey, September 30.

Claim.—"What I claim to be my invention is, not the division into equal parts, with or without subdivisions of one or more of those parts of the continuous edge of a scale or rule; nor the use of a vernier for measuring or describing right lines, nor the manner of attaching the vernier slide to the main plate of the instrument, nor the use of a lever, or slow motion screw, for adjusting the motions of the vernier slide; but the combined application, in one and the same instrument, of the graduation upon the edge, (to obviate the imperfection and inconvenience attending the use of dividers or compasses,) and the slide carrying with it the several primary divisions of the unit, and those divisions carrying with them respectively, by means of the vernier, the several secondary divisions into hundredths, or otherwise, so as to enable the operator to distinguish and apply hundredths or half hundredths of the smallest unit, with a great rapidity, precision, and ease, as tenths of the same unit, with the scale graduated on the edge, without a slide, and so, likewise, that whatever parts of a unit are required, or whatever the whole length of line to be measured, the whole amount of motion required, in lengthening or shortening the instrument, is only equal to the number of additional or intermediate hundredths, or other subdivisions, never exceeding one-tenth of the unit of measure."

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71. For an *Improvement in Fountain Pens;* Newell A. Prince, New Gloucester, Maine, September, 30.

Claim.—"What I claim as my invention is, the improvement of the hollow, flexible and long extension of the reservoir or tube, to extend up and be secured to the arm of the writer, substantially in manner and for the purpose as specified."

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72. For an *Improvement in Machines for Sawing Volutes;* Elijah Whiten, Hingham, Massachusetts, September 30.

"The nature of my invention consists in giving the block to be sawed, by a novel mechanical arrangement, two motions, rotary and rectilinear, whereby the block is fed up to the saw, in such a manner as to be, when sawed, a single spiral sheet, or scrowl of wood, or in concentric layers or sheets."

Claim.—"I do not claim the carriage, for carriages have been and are now applied to saw-mills; but what I do claim as new is, 1st, The manner in which I produce the two motions necessary to be given to the block, in order that it may be sawed in the required form, viz: the screw rod with its right and left screws cut upon it, mashing into the pinions, by which motion is communicated to the horizontal rods, the toothed wheels, pinions, or spurs grasping the edge of the block, and causing it to rotate, in combination with the bevel pinions, screw rods, and arm, by which a rectilinear motion towards the saw is given the carriage and block, producing the result described."

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73. For an *Improvement in Mitre Boxes;* Matthew Spear, Bowdoinham, Maine, September 30.

Claim.—"What I claim is, one or two rotary saw guides, with sliding gauge rests, and mechanism for rotating the guides, and fixing them in any desirable position or positions, as specified, in combination with the improvement of making or applying the uprights or vertical posts of the saw to the bars, so as to be capable of being turned down to an angle with the horizon, for the purpose as described."

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74. For an *Improvement in Shields for Valves;* Alexander Jimason, Parkesburgh, Pennsylvania, September 30.

"This improvement consists in furnishing the valve with a shield, to protect it from the action and reaction of the fluid which surrounds it, when in operation, thus preventing, in a great measure, the rapid destruction of the valves, valve-seats, and chambers, in which the valve is generally made to work."

Claim.—"What I claim is, surrounding the valve by a shield, constructed substantially in the manner as herein described and set forth, and fitting closely enough to regulate the ingress and egress of the water or steam, to such a degree as to prevent the slamming of the valve, in opening and closing."

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75. For an *Improvement in the Manufacture of Clay Pipes;* Joseph Putnam, Salem, Massachusetts, September 30.

"My improvements are made upon an apparatus for the same or a similar purpose, for which letters patent were granted to me, dated January seventeenth, in the year of our Lord one thousand eight hundred and twenty-seven, and recorded anew in the Patent Office, on the twelfth day of February, in the year of Lord one thousand eight hundred and thirty-eight, to which patent reference should be had, and are represented in the figures of the accompanying plate of drawings."

Claim.—"Having thus described my improvements in apparatus for moulding clay pipes, I shall state my claim as follows: What I claim is, the use of the wire gauge frame, constructed substantially as above described, in moulding clay or earthen pipes, in the manner and for the purpose above specified.

"I also claim the improvement above specified, in the sack, in which said pipes are suspended to be dried; said improvement consisting in confining said sack to two rails, kept parallel by means of cross bars, forming with them a rectangular frame, as herein above described."

Designs for September, 1851.

1. For a *Design for Stove Plates;* Calvin Fulton, Rochester, New York, September 2.

Claim.—"What I claim as my invention is, the ornamental design of a stove plate, substantially as herein described and represented."

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2. For a *Design for Cast-Iron Bedsteads;* Pellatiah M. Hutton, Troy, New York, September 2.

Claim.—"What I claim as my invention is, the designs and ornaments upon the parts A, B, C, and D, combined as in the drawing hereunto annexed, as applied to iron bedsteads."

3. For a *Design for Stoves;* Anthony W. Jones, City of New York, Assignor to James McGregor, Jr., September 2.

Claim.—"I claim as my invention or production, the above described and illustrated design for the several plates of a stove, as fully set forth; that is to say, I claim the design on each of the plates separately, and on all the plates in combination."

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4. For a *Design for Stoves;* Samuel H. Tailor, Kensington, Pennsylvania, Assignor to North, Harrison & Chase, Philadelphia, Pennsylvania, September 2.

Claim.—"What I claim as my invention is, the ornamental design for a stove, as herein described, and as represented in the annexed drawings."

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5. For a *Design for Stoves;* Silas Merchant, Cleveland, Ohio, September 2.

Claim.—"I disclaim the hearth *w*, in fig. 1, and the projection L, in fig. 2; but what I do claim as my design and production is, the basso-relievo ornaments, form, and configuration of the doors, E, F, and G, in fig. 1, which are substantially the same as before described in the doors, fig. 2, fig. 3, and fig. 4."

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6. For a *Design for Floor Oil Cloths;* James Hutchinson, Troy, New York, Assignor to Deborah, Albert E., and Nathaniel B. Powers, Lansingburgh, Pennsylvania, September 2.

Claim.—"What is claimed as my invention is, the arrangement of figures forming a design for floor oil cloths, as shown in the aforesaid drawing."

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7. For a *Design for Shovel Stands;* Charles Zeuner, Assignor to M. Greenwood & Co., Cincinnati, Ohio, September 9.

Claim.—"What I claim as my invention is, the design and configuration of the stand as a whole, as fully shown and represented in the drawing at fig. 1. I claim also the particular ornamenting of the shell or dish used as a base, and the configuration and ornamenting of the standard or upright, and the design of the hooks and the handle, as fully shown and represented in the drawings at figures 1, 2, and 3, and herein before fully set forth."

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8. For a *Design for Metallic Gates;* Ebenezer Weeman, Charlestown, Massachusetts, September 16.

Claim.—"I do not claim the design for the posts or pillars in this gate-way, but only the form of the gate suspended between the posts; and I claim the design for gates of this pattern of whatever size they may be made, and of whatever metal they may be cast, and for whatever purposes they may be used."

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9. For a *Design for a Ventilating Stove or Furnace;* Elijah P. Penniman, Rochester, New York, Assignor to Henry Brittan, Cobourg, Canada, September 16.

Claim.—"What I claim as my production is, the design, marked fig. 1 and fig. 2."

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10. For a *Design for Tables;* Nathan Chapin, Syracuse, New York, September 30.

Claim.—"What I claim as my invention is, the design and configuration of table pillars in the form of vines, supporting by their branches the drawer and upper part of the table with flaming scroll ballustrade pillars, supporting a rim which encircles the main pillars, together with the configuration of an ornamental open work drawer and capital exposed to view on all sides; the whole combining various styles of architecture, as herein before described.

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11. For a *Design for Stove Fronts;* Ezra Ripley, Troy, New York, September 30.

Claim.—"What I claim is, the design and configuration of parlor stove fronts, substantially the same as described and represented."

OCTOBER.

1. For an *Improvement in Machines for Opening and Cleaning Flocks;* Ephraim C. Brett, Great Barrington, Massachusetts, October 7.

"The nature of my invention consists in the employment of a circular and a concave grater, between which the flocks is passed and separated, and thence passes into a fan chamber, and is blown out through a conducting spout, whilst the dirt settles and separates therefrom."

Claim.—"What I claim as new is, the arrangement and combination of the conical revolving grater within the close grater case, combined with the blowers, in the manner and for the purpose substantially the same as described and represented."

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2. For *Improvements in Apparatus for Applying Flocks to Cloth;* Daniel Pratt and Ransom Pratt, Elmira, New York, October 7.

"The nature of our invention consists in passing the cloth underneath a revolving screen, said screen containing the flock, which is prevented from being packed and kept in a tight state by means of a beater within the screen; the flock falls through the screen upon the cloth, which passes between the corrugated rollers, said rollers working the flock, in a measure, into the texture of the cloth, and preparing it for the operation of fulling."

Claim.—"What we claim as new is, the revolving screen, having a beater within it on a shaft as described, in combination with the corrugated rollers, constructed and operating in the manner and for the purpose substantially as set forth."

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3. For an *Improvement in Tanning;* Nathaniel C. Towle, Washington, D. C., October 7.

Claim.—"What I claim as my invention or discovery as a new and useful improvement is, the use of arsenic or arsenceous acid, substantially in the manner and for the purposes herein set forth. The peculiar properties of arsenic, by which it tends to suspend the natural tendency of the animal fibre to decomposition upon the extinction of animal life, are well known, and of course they are not patentable; but their application to the processes of tanning, and otherwise preparing skins and hides for useful purposes, by which they are rendered stronger and more durable, is believed not to have been heretofore known and used.

"I do not, therefore, intend to limit my claim to any particular mode or period of using the article; but I shall apply it in such form or in such strength of solution as the nature of the case may require, to effect the objects named. Workmen should guard against the absorption of the poisonous qualities of the arsenic, while immersing or handling the skins in the liquor, by using tools or wearing india rubber gloves. After the skins are taken out of the liquor, and rinsed thoroughly, the danger ceases."

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4. For *Improvements in the Endless Chain Propeller;* Charles F. Fisher, New Orleans, Louisiana, October 7.

Claim.—"I do not mean to claim the invention of the endless chain propeller, or the application of the endless chains to communicate power from one wheel to another; but what I do claim as new is, suspending the endless chain propeller, which is to be put in motion by an endless chain running on the side wheel on the principal drum under water, in a rigid frame, inside of the water-tight chamber, the frame being capable of an upward and downward motion, parallel to itself, by means of the four racks and pinions, or their equivalents, acted upon by gearing connected each to each; said frame being connected with an indicator, by which the situation of the propeller may be ascertained; the whole constructed substantially in the manner and for the purposes herein described.

"2d, I claim the sliding lid to the aperture in the bottom of the vessel, through which the propeller projects when lowered for operation; but when the propeller is raised inside of the vessel, the lid closes the aperture, so that the speed of the vessel may not be impeded, when under sail alone, by the action of the water on the aperture in the bottom; said sliding lid being worked by a screw, or its equivalent, in connexion with an indicator, by which the position of the lid can be seen, substantially as herein described."

5. For an *Improvement in Devices for Sowing in a Seed Planter;* W. P. Clements, Ellerslie, Georgia, October 7.

"The nature of my invention consists in the novel manner of availing of the natural motion of the shoulders of a horse or other animal, while walking and propelling a drill, to operate the seed dischargers, so that at each step of the animal its shoulder blades shall act alternately upon levers, reciprocating the arms, working inside the hopper, so as to discharge the desired quantity of seed, without the aid of wheels, cams, or any other machinery than the simple arrangement represented in the drawings, which is not more complicated or more liable to get out of order than an ordinary plough."

Claim.—"What I claim as new is, the novel manner of discharging the seed by the natural motion of the horse or animal, while in the act of walking and propelling the drill, without the aid of wheels, with the arrangement of levers, arms, &c., for discharging the seed, or their equivalents, operating in the manner and for the purpose herein fully set forth and represented."

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6. For an *Improvement in Escapements for Time Pieces;* James Fulton, Louisville, Kentucky, October 7.

Claim.—"What I claim is, the combination of the pallets and lever or levers here set forth, with the above described mode of communicating impulse to the balance in time pieces which keep time by means of a balance."

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7. For an *Improvement in Running Gear of Locomotives;* James H. Murrill, Manchester, Virginia, October 7.

"The nature of my improvement consists in arranging a pair of large unflanched driving wheels at the frontward end of the locomotive, between the ordinary flanched truck wheels, in such a manner as to support the frontward portion of the locomotive engine, heretofore supported by the truck wheels."

Claim.—"What I claim as my invention is, the manner of employing the unflanched driving wheels, connected and arranged as described, with the flanched truck wheels, at the forward end of the engine, in combination with the flanched driving wheels, for the purpose of increasing the traction or adhesion of the driving wheels to the rails, for overcoming steep grades without increasing the weight of the engine."

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8. For *Improvements in Revolving Boilers;* William Scott, Rising Sun, Indiana, October 7.

"The object of my invention is to construct a boiler that shall, with a facility for the rapid generation of steam, combine great economy, both in the size and consequent expense of the apparatus, and in the amount of water requisite, and avoidance of the danger of explosion by unduly heated plates. My improvements have more especial reference to boilers which rotate upon a central shaft or axis."

Claim.—"What I claim as new is, the combination of the small cylinders, provided with apertures and rims as described, with the distributing chamber; the whole revolving around a common axis, and operating substantially as described."

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9. For an *Improvement in Revolving Breech Pistols;* Joshua Stephens, Chicopee, Massachusetts, Assignor to the Massachusetts Arms Company of Chicopee Falls, October 7.

Claim.—"I do not claim to make the latch hook alone revolve on the barrel; but I claim the improvement of so connecting or combining the latch hook, the slide bearing of the rammer, and the lever, with the barrel, by means of the swivel tube, or any analogous contrivance, as to enable them to be all simultaneously turned laterally, or revolved around the axis of the barrel, and thereby remove any obstruction to the elevation or upward movement of the barrel, such as may be necessary in order to effect the removal of the cylinder of charging chambers, from the arbor on which it is supported."

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10. For an *Improvement in Apparatus for Warming Air and Water for Dwellings;* Le Grand C. St. John, Buffalo, New York, October 7.

"The nature of my invention consists in making a fire-proof apartment, with either

circular or rectangular sides, from the lowest extremity of the house to the roof. At the bottom of this apartment are furnaces, the heat of which enters the apartment. The pipes of stoves enter the same apartment, and wind around its sides to a chimney near the roof. In cold weather the heat is taken from this apartment in pipes to warm the house, and in warm weather it is turned out of the house, through the chimney. Any requisite degree of heat may be made without waste of fuel. If the fire from the cooking stove, which passes through the pipe, does not warm the house sufficiently, the heat of one or more furnaces may be added. The top of the apartment has a bowl in the roof, from which the water may pass down in a pipe in the apartment to a reservoir, or pass into a structure, filling cisterns opposite the different stories, and the surplus then pass, by pipes, into a reservoir, from whence it may be re-elevated for the supply of upper rooms."

Claim.—"What I claim as my invention is, the construction of a fire-proof apartment in houses, extending from the lowest extremity of the house to the roof, with furnaces at the bottom; the smoke pipes of other fires, entering it, and winding along its walls to a chimney at the top, and with openings to let the heat in the apartment into the house, or up the chimney; and also for the construction of cisterns within the fire-proof apartment, with the pipes, as above described."

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11. For an *Improvement in Machines for Cutting Screws on Posts and Rails of Bedsteads;* Orion Thornley, Lebanon, Indiana, October 7.

"The principal feature of this invention consists of such an arrangement of mechanism as to cut accurately the screw threads upon both ends of a beam of a right and left screw bedstead, and at the same time, and by the same operation, cut the inverse thread of the sockets of two posts, which are to receive the two screw tenons of the said rail."

Claim.—"What I claim as my invention is, the trifurcated travelers, in combination with the right and left screw axle, the carriage, saddles, hollow axle, and cutters, whereby the threads of two beam tenons and two sockets are cut by one and the same operation; the several devices being constructed and arranged in the manner and for the purposes herein set forth."

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12. For an *Improvement in Portable Elevated Ovens;* Patrick Killin, Mount Healthy, Ohio, October 7.

"My oven is composed essentially of two compartments, the one above the other; in the upper, the articles to be cooked are placed; the lower acts as a receiver, into which the gases are conducted after they have given off a portion of their heat in their passage through radiating flues, projecting upwards into the body of the baking compartment, and from which they are discharged; the gases and flame in passing from the receiver through the ascending pipe, are conducted directly against the bottom of a boiler placed on the pot hole, in the top of the stove, after which they are conducted by the descending flue to the chimney. The whole constitutes a convenient portable auxiliary stove, which can be heated by the ordinary earthen or iron furnaces in common use."

Claim.—"What I claim as my invention is, the arrangement as herein described, of the inner and outer concentric tubes with respect to the oven and pot hole as described, whereby the oven is equally heated by a small fire, and the heat is directed by the inner upright pipe against the bottom of the kettle or other vessel, thus enabling the user to conduct, simultaneously, the several operations of baking and boiling with a small fire, and with economy of fuel."

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13. For an *Improvement in Machines for Cutting Screws on Rails of Bedsteads;* Spencer Lewis, Rochester, New York, October 7.

"The nature of my invention consists in constructing a hand implement for cutting right and left handed screws on tenons of bedstead rails; said implement consisting of a reversible cylinder, provided at either end, on the opposing sides thereof, with a V shaped cutter, each combined in a peculiar manner. Also, in having locking and unlocking screw shanks made to slide horizontally in the ends of arms which embrace the end of the rail, and securely hold the implement thereto, during the operation of cutting the right and left screw; and likewise, in having a central screw shaft, projecting from the cross-head of the reversible cylinder, (to the end of which the power to rotate said cylinder is applied,) surrounded by a hollow shaft, provided with an inverse and male screw thread,

and enclosing the latter with a cylindrical or other shaped case, having an inverse screw thread, matching with the male screw thread of the hollow screw shaft; the whole composing a self-reversing, self-locking and unlocking implement for cutting the right and left screw, by an alternate reverse rotation and position of the cylinder; the implement being adaptable to both ends of the rail alike."

Claim.—"What I claim as my invention is, 1st, in combination with the central screw shaft D, through which the rotation of the cylinder A is effected, the hollow screw shaft E, provided with an inverse and male screw thread, and cylindrical case F, having an inverse screw thread matching with the male screw thread of the hollow shaft E; the whole being arranged as above set forth, and operated by means of the bolts, *c* and *b*, and cam H, on the cross-head, in such a manner as to feed the cylinder A, frontward, simultaneously with a right or leftward rotation thereof, as fully described and shown in the drawings.

"2d, I also claim the employment of the screw shanks, J, J, provided with toothed wheels, K, K, made to match with toothed or ribbed plates L, L, forming one of the sides of each box, the outer ends of said screw shanks J, J, being confined in inverse screws, formed in plates *d*, *d*, whilst their inner or pointed ends are supported by plates *k*, *k*, having projections k^2, k^2, against which the shoulder of the rail acts, for the purpose of actuating said screw shanks rotarily, for imparting thereto a lateral movement in such a manner as to cause their pointed ends to enter the rail, and be locked thereto by the spring levers M, said screw shanks J, being detached from the rail when unlocked, by simply withdrawing the implement therefrom, as fully described and shown in figs. 2 and 3.

"3d, I further claim the employment of the semi-circular plate O, of the cross-head C, in combination with the spring levers M, M, for the purpose of actuating said spring levers M, in locking and unlocking the plates *k*, *k*, of the screw shanks, J, J, at the terminus of the receding movement of the cylinder A, whether cutting the right or left screw, as described and represented.

"4th, I also claim confining each V shaped cutter P, to the reversible cylinder A, by means of the segmental brace plate R, notched at one end, so as to interlock with the end of the shank of the cutter projecting through an opening S^3 in the cylinder, whilst its opposite end is made to fit against the frontward portion of the cutter at S^2, said segmental brace plate R, being secured by means of a screw bolt S, passing through it and the cylinder, and pressing upon the shank of the cutter P, in such a manner as to form a complete lock thereto; there being a binding pressure at four points upon the cutter, viz: at either extremity thereof, at the connexion of the brace plate R, with the frontward end of the cutter, and the centre by the confining screw bolt S, thus rendering it impossible to move the cutter without fracturing the segmental brace plate R, and displacing the screw bolts S, as described and represented."

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14. For an *Improvement in Locomotives Moved by the Power of Animals;* Clement Masserano, Turin, Sardinia, Assignor to Clement Masserano, Josephine Wickliffe, Administratrix of R. Wickliffe, Jr., Lexington, Kentucky, Charles Carinzi, Andre Crestadora, Pellegro Rocca, and Louis B. Migone, Genoa, Sardinia, October 7.

"The object of my invention is, to apply the force exerted by animals to the transportation of passengers and merchandize, with greater economy than has hitherto been obtained, and at the same time to render the attainment of a high velocity practicable, without urging the animals employed beyond the speed at which they can work to the best advantage, and without forcing them to work in disadvantageous positions. The first of these objects is effected by constructing the mechanism employed, in such manner that the friction of the moving parts is reduced to the lowest limit attainable, without uselessly increasing the complexity and weight of the mechanism; and the second object is attained by mounting the animals upon the car or other vehicle to be moved, in such manner that the animals can work in their best positions, and to the best advantage, whether the plane in which the vehicle moved be horizontal or inclined; my improvements are applicable to every species of locomotion, whether on land or in water."

Claim.—"What I claim as new is, 1st, the combination with the endless platform, of an adjusting apparatus, by means of which the inclination of the platform to the frame of the power carriage may be varied, to enable the horses to work to the best advantage, whether to accelerate or to retard the movement of the impulsoria, in traversing ascending or descending grades.

"2d, I also claim the method of connecting the frame of the impulsoria with the pilot,

by means of a longitudinal shaft, which is fitted with mechanism, by means of which the impulsoria can be adjusted transversely, to keep the driving axle level, and to prevent the endless platform from sloping cross-wise, when traversing a road one of whose sides is higher than the other.

"And lastly, I claim in an apparatus adapted to propulsion by animals, substantially as herein described, the employment of a single driving wheel, arranged in such manner as to admit of being leaned towards the hill in traveling across slopes, to prevent a transverse sloping of the endless platform on which the animals walk, when the wheel thus arranged is steadied by a pilot before, and a follower behind, or their equivalent, substantially as herein set forth."

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15. For an *Improvement in Circuit Changers for Electro-Magnetic Telegraphs;* Chas. S. Bulkley, Macon, Georgia, September 2.

"In order to transmit intelligence by telegraph, for very long distances, it has been found necessary to have what are called "relay circuits;" the vibrations of making and breaking the circuits in writing being communicated from one to the other, by "receiving magnets." But by these means the writing can only be done in one direction, unless a re-arrangement is made in the connexions, which can only be done by the operators at the intermediate stations, and consequently, if they wish to write back, or if an error takes place, or any other difficulty occurs, the writer cannot be notified of it, without considerable difficulty. My invention is designed to obviate these defects, and to put it in the power of the operators at either end of the line to arrange the circuits at the intermediate or relay stations, suitably for them to transmit the message, and the operator at the opposte end having the power to interrupt and write back at pleasure; and besides, in the event of any of the circuits breaking, the operator is immediately aware of it, by his own instrument ceasing to operate."

Claim.—"What I claim as new is, the "circuit changer," substantially as above described, in combination with the arrangement of wires, magnets, &c., as set forth, for the purpose of enabling the operator at either one of two distant stations to arrange the connexions at the intermediate stations, so that he can write through to the other end station at pleasure."

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

A few Suggestions as to the Manner of Laying Out a Propeller, when the Dimensions of the Vessel are given. By J. W. Nystrom.

When a propeller vessel is to be built, we first have the dimensions of *tonnage*, *length*, and *beam*. From them the ship-builder lays out the lines of the vessel, and ascertains the tonnage, greatest transverse section, area of the displacement, draft of water, &c. From these the propeller is to be constructed, and suppose the following to be the dimensions, viz:

Length on Deck, ...	230 feet.
Beam, ...	35 "
Draft of Water from bottom of keel, . .	15·5 "
Greatest transverse sectional area of displacement, .	500 sq. ft.
Displacement, ...	1770 tons.

Diameter of Propeller.—The diameter depends on the draft of water, and in this instance can be made 14 feet, when the draft of water is 15·5.

Pitch.—The pitch of a propeller depends on the arrangement of the steam engine, as if it is with gearing or direct action.

Let the number of revolutions of the propeller be n, when the number of revolutions of the steam engine is n', a proper pitch will be

$$P = 2{\cdot}5\,D\sqrt{\frac{n'}{n}}, \quad . \quad . \quad . \quad . \quad . \quad (1.)$$

in which D denotes the diameter of the propeller in feet, and P the pitch, also in feet.

If the propeller is to be centripetal, the pitch can, without detriment, be taken larger than with straight-bladed propellers, and in this instance we will construct the propeller for a direct action steam engine, and take the pitch

$$P = 2\tfrac{5}{8}\ D = 2{\cdot}625 \times 14 = 36{\cdot}75 \text{ feet.}$$

Slip.—The slip depends on the displacement, and greatest sectional area of displacement, when the propellers have equal pitch in proportion to the diameter.

$$S = \frac{\boxtimes^2 + \sqrt[3]{Q^2}}{10\,A}, \quad . \quad . \quad . \quad . \quad . \quad (2.)$$

or

$$S = \frac{500 + \sqrt[3]{1770^2}}{1540} = \frac{646}{1540} = 0{\cdot}42 \text{ per ct.}^*$$

$\boxtimes^2 = 500$ square feet, greatest sectional area.
$Q = 1770$ tons displacement.
$A = 154$ square feet, or $0{\cdot}785\,d^2$.

Propellers with less pitch in proportion to the diameter will give less slip, but in those instances the slip is not a measure of loss of effect or quality of propellers. The slip is nearly constant with different velocities until a certain limit; when it exceeds that, the slip will increase by the excess of velocity.

Velocity of the Propeller.—The velocity of propellers depends on the *pitch*, *diameter*, and *slip*, and can by them be proportioned to suit the steam engine. The proper velocity or number of revolutions per minute n, in order to give the vessel the highest speed with the greatest economy of fuel, is

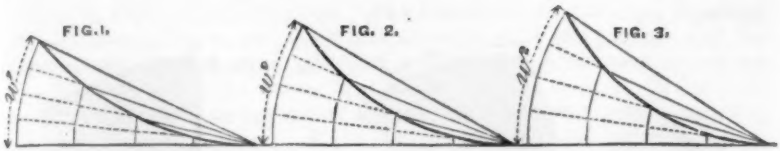
$$n = \frac{200}{S\,P}\sqrt{D}. \quad . \quad . \quad . \quad . \quad . \quad (3.)$$

$$n = \frac{200}{0{\cdot}42 \times 36{\cdot}75}\sqrt{14} = \frac{200 \times 3{\cdot}74}{0{\cdot}42 \times 36{\cdot}75} = 48{\cdot}5 \text{ revolutions.}$$

From this number of revolutions, pitch, slip, and diameter, the *power* of the steam engine is to be ascertained; but, before entering into that, we will finish the propeller. The propeller to be centripetal; (see Vol. XXI., 3d series, page 345,) we have the angle $w°$ as follows:

* Perhaps it will be deemed that 42 per cent. slip is too much compared with the common announcement of slip; but in a calculation like this the *fact* must be followed. We often hear, and sometimes see, the slip *on paper* to be 10 or 20 per cent., which does not always correspond with the slip *in the water*.

Fig. 1.
$$^{\circ}w = \frac{D\,n^2\,S^2}{200}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4.)$$
$$^{\circ}w = \frac{14 \times 48{\cdot}5^2 \times 0{\cdot}42^2}{200} = 29^{\circ}.$$



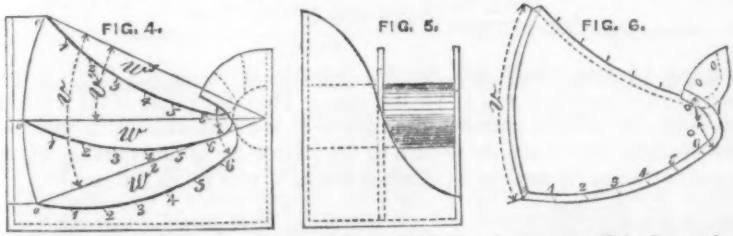
Compute two more angles, ^1w and ^2w, from the following formulæ:

Fig. 2.
$$^1w = \frac{^{\circ}w}{2}(2\text{—}S). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5.)$$
$$^1w = \frac{29}{2}(2\text{—}0{\cdot}42) = \frac{29 \times 1{\cdot}58}{2} = 22{\cdot}91^{\circ} = 22^{\circ}\ 55'.$$

This is to be the first edge of the propeller, and the following the after edge:

Fig. 3.
$$^2w = \frac{^{\circ}w}{2}(2+S). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6.)$$
$$^2w = \frac{29}{2}(2+0{\cdot}42) = \frac{29 \times 2{\cdot}42}{2} = 35{\cdot}09 = 35^{\circ}\ 5'\ 20''.$$

In each of these angles, $^{\circ}w$, ^1w, ^2w, construct a curved line, as in fig. 1, 2, and 3; place them on a common axis, fig. 4, so that the planes on which the curved lines are drawn shall be at right angles to the axis, and a distance between the two curved lines ^1w and ^2w equal to the length l of the propeller. See fig. 5 and 8.



Number of Blades.—The number of blades in a propeller depends on the *slip*, and the angle V, fig. 8. The more slip, and the larger the angle V, the less the number of blades should be. As to the number of blades in a propeller, it is known from experiment, that a less number do better or just as well as a greater; it may be so under some circumstances, but is not always. In canal and tow boats, where the slip is considerable, a two or three-bladed propeller will no doubt do the best execution, but for vessels which are to run fast, and the propeller to have a slight slip, a six-bladed propeller should give the greatest effect; but in such cases the propeller must be particularly constructed, and the length l, fig. 5

and S, be only one-quarter ($\frac{1}{4}$) of the diameter. If this is disproportioned, and the blades are wrong, of course there ought to be a less number of them; but whatever the number of blades may be, take the length l from the following formula (7). The number of blades is denoted by the letter m, and in the propeller we are constructing we will take five (5) blades.

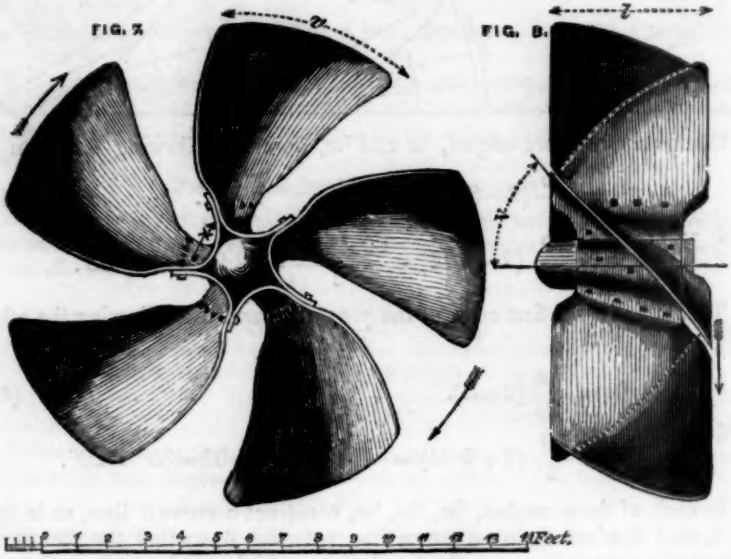


Fig. 5 & 8.

$$L=\frac{0{\cdot}6\,P}{m}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7.)$$

$$L=\frac{0{\cdot}6\times 36{\cdot}75}{5}=4{\cdot}2 \text{ feet.}$$

Or say 4·5 feet, which will be the distance between the two curved lines ^1w and ^2w, fig. 4 and 5, on the axis. Place the plane of the curved line $^\circ w$ in the middle between the planes of the curved lines ^1w and ^2w; draw straight lines from the centre to the extremity of the curves; place the curved lines ^1w and ^2w so that the angle V will be as follows:

Fig. 4.

$$V=\frac{360\,L}{P}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8.)$$

$$V=\frac{360\times 4{\cdot}5}{36{\cdot}75}=44{\cdot}2=34^\circ-12'.$$

Place the curved line $^\circ w$ between the curves ^1w and ^2w, so that the angle ^1V will be

Fig. 4.

$$^1V=\frac{V}{4}(2+S). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9.)$$

$$^1V=\frac{44{\cdot}2}{4}(2+S)=\frac{44{\cdot}2\times 2{\cdot}42}{4}=26{\cdot}74^\circ=26^\circ\ 44'\ 30''.$$

When the curves are laid down in these positions, make a drawing of the propeller, as fig. 7 and 8, which represents a propeller made of wrought iron. If made of cast iron, these curved lines ^{0}w, ^{1}w, and ^{2}w lay out in loom. Build to the curves a box, fig. 4 and 5; form it in the hub after the drawing, so that x is equal to x. In this box build a pattern of boards, about $2\frac{1}{2}$ by 3 inches. The boards are to run from the curve ^{1}w to the curve ^{2}w, so that the edges or seams may run parallel with the same figures on the curves, and form a regular curve, for instance an arc of a circle, touching the curve ^{0}w. When the slip exceeds 50 per cent. it will be necessary to pay more attention to this curve, and lay out five w curves instead of three. From this pattern cast a block of cast iron, represented in fig. 6; bore holes in this block, corresponding to the holes for the screws by which the propeller blades are screwed together. Fit a pasteboard on the face side of the block, and make it the same shape as the propeller blades are to be; when fitted precisely, mark the holes on the pasteboard; from this cut out one propeller blade from the sheet iron, and bore the holes accurately from the pasteboard. From this blade cut out the rest of the propeller blades, and one more than the number of blades in the propeller. Afterwards bend these blades over the block, (fig. 6,) so that the holes correspond with each other; then the blades are ready to screw together. If the holes are not bored before the blades are bent, they must be marked on the block, (fig. 6,) if not the blades will never come in their proper position, and it will cause much trouble in putting them together.

The hub can be cast in the propeller after the blades are screwed together, or it can be cast separately as a round cylinder.

Now the speed of the vessel can be calculated, and will be in miles per hour,

$$M = \frac{60\, n\, P(1-S)}{5280}. \qquad (10.)$$

$$M = \frac{36{\cdot}75 \times 0{\cdot}58 \times 48{\cdot}5 \times 60}{5280} = 11{\cdot}75 \text{ miles per hour.}$$

The distance from Liverpool to New York being 3100 miles, the vessel will run that in a time of $\frac{3100}{24 \times 11{\cdot}75} = 11$ days. To Boston, in 10 days $7\frac{1}{4}$ hours. To Halifax, in 8 days $21\frac{1}{2}$ hours.

The effect of a steam engine, sufficient to drive the propeller 48·5 revolutions per minute, will be found by the following formula, in horse power:

$$H = \frac{n^2 A}{1950} \sqrt{PS}. \qquad (11.)$$

$$H = \frac{154 \times 48{\cdot}5^2}{1950} \sqrt{36{\cdot}75 \times 0{\cdot}42} = 735 \text{ horses.}$$

To be two direct action condensing engines. Let us determine the effectual pressure per square inch to be 25 pounds, say pressure in the boiler to be 20 pounds, cutting off at $\frac{1}{3}$ stroke; the mean pressure will be 14 pounds, vacuum 11 pounds, effectual pressure, p, $=25$ pounds.

The area of the cylinder piston, in square inches, will be found by the following formula:

$$a = \frac{4{\cdot}24\, n\, \mathrm{A}\, \sqrt{\mathrm{P\,S}}}{p\, s\, (1-f)}. \quad . \quad . \quad . \quad . \quad . \quad (12.)$$

In which s denotes the stroke of the piston in feet, and f = friction, working pumps, and per cent., which, in this intended steam engine, will be $f = 0{\cdot}32$ per cent. Let the proportions of stroke and diameter of the piston be as 2 to 3, we have the diameter in inches:

$$d = \sqrt[3]{\frac{94\, n\, \mathrm{A}\, \sqrt{\mathrm{P\,S}}}{p\, (1-f)}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13.)$$

$$d = \sqrt[3]{\frac{94 \times 48{\cdot}5 \times 154 \sqrt{36{\cdot}75 \times 0.42}}{25 \times (1-0{\cdot}32)}} = 54{\cdot}7 \text{ inches.}$$

Say 56 inches diameter and 36 inches stroke, the effect of the steam engine, in horse power:

$$\mathrm{H} = \frac{a\, p\, s\, n}{33000} \cdot 4\, (1-f). \quad . \quad . \quad . \quad . \quad . \quad . \quad (14.)$$

$$\mathrm{H} = \frac{2463 \times 25 \times 3 \times 48{\cdot}5}{33000} \cdot 4\, (1-0{\cdot}32) = 740 \text{ horses.}$$

Cut off the steam at one-third of the stroke, c being the cubic feet of steam for each revolution, and k denotes the volume of steam compared with water at the given pressure.

$$c = \frac{56^2 \times 0{\cdot}785 \times 12 \times 4}{1728} = 68{\cdot}4; \text{ say 70 cubic feet.}$$

The consumption of coal, if anthracite, will be:

$$\text{Coal} = \frac{c\, n}{x\, k}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (15.)$$

$$\text{Coal} = \frac{70 \times 48{\cdot}5}{4{\cdot}8 \times 770} = 0{\cdot}918 \text{ tons per hour.}$$

That is when one pound of anthracite coal evaporates 8 pounds of water per hour; or call the number of pounds of water $= w$, evaporated per pound of coal, we have for x,

x	:	w
3·5	:	6
4·18	:	7
4·45	:	7·5
4·77	:	8

x	:	w
5·08	:	8·5
5·35	:	9
5·67	:	9·5
6	:	10

Plate XIII. represents a section of a vessel, of the aforesaid dimensions. On the bottom lays two inclined, direct action, condensing steam engines.

A, The Engineer's Room.
B, First Class Cabin.
C, Ventilator and Sky-Light.
D, State Rooms.
E, Store Rooms.
F, Passages.
G, House on Deck.
H, Berths.

The engine is manœuvered in the engine room A, by the three rods *a*, *b*, and *c*, which run through the columns in the engineer's room.

The four gauges on each side are the steam gauge, vacuum gauge, water gauge for the boiler, and salinometer; in the front is a clock and counter.

a is for regulating the injection water, connected with the injection cock *k*.

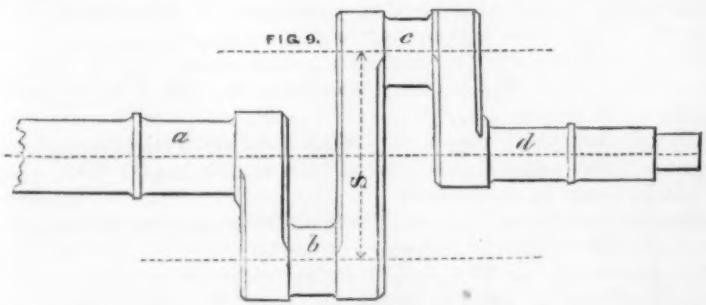
b for reversing the eccentrics, to back and go ahead, connected with a conical cog wheel.

c for regulating the steam to the engine; by the same rod steam can be given to full stroke.

d Cylinder heads.
e Injection water pipe.
f Steam pipe.
g Steam chest.
h Exhaust pipe.
i Discharge pipe.
k Injection cock.
l Condenser.
m Air pumps, double and direct action.
n Feed and Force Pumps, double and direct action.
o Air vessels.
p Eccentrics for the steam valves.
q Frames and guides.
r Steam cylinders.

The engines are working on a double crank, represented in fig. 9. The scale is $\frac{3}{8}$-inch to a foot. The cranks are opposite to each other; therefore the steam engines *do not work at right angles;* but if it is thought more desirable that they should, the cranks can be set in any angle; this is a matter of small consequence compared with the friction in the bearings *a* and *d*, which the opposite cranks prevent, and it is the reason why the stroke of the piston can be taken so short in proportion to the diameter.

FIG. 9.



Now for the *strength* of this crank, which, at first sight, promises little for durability. Let the end *a* be the continuation of the propeller shaft, and the steam engines be applied at *b* and *c*; let the force which is applied at *c* be denoted by the letter *c*. The force which acts to twist the crank

at b will be $c\,s$; but as there is a bearing at d, the resistance at b acts to twist the crank at c with a force $= b\,s$; if the crank should break, the force c must break it both at c and b at the same time, which will require twice the power that would break it only at b; or $\frac{c\,s}{2}$ will be the force by which the crank should be twisted at b, which is exactly the same as the force c applied to b, to twist the shaft at a, or if the diameter at a, b, and c be equal, the strength of the *opposite cranks* will be the same as a common single crank.

Let D be the diameter of the propeller shaft in inches, and of wrought iron.

$$\mathrm{D} = 8{\cdot}15\sqrt{\mathrm{D\,P\,S}}. \quad . \quad . \quad . \quad . \quad . \quad (16.)$$

$$\mathrm{D} = 8{\cdot}15\sqrt{14 \times 36{\cdot}75 \times 0{\cdot}42} = 12 \text{ inches.}$$

The diameter at d will be the same as the diameter for a crank pin of a common single crank; or

$$\delta = \sqrt{\mathrm{D}^2 + 1{\cdot}2s^2} - 1{\cdot}1s. \quad . \quad . \quad . \quad (17.)$$

$$\delta = \sqrt{12^2 + 1{\cdot}2 \times 3^2} - 1{\cdot}1 \times 3 = 8{\cdot}5 \text{ inches.}$$

This kind of crank was tried and tested by a Swedish Engineer, O. E. Carlsund, and the results were most satisfactory. The engines were 30 inches in diameter and 18 inches stroke; they made from 105 to 110 revolutions per minute. The air pumps were direct action, working at the same speed with 18 inches stroke; pressure in the boiler, 30 pounds to the square inch, cutting off at one-third of the stroke; the air pumps and valves worked silently.

In direct action propeller engines, the arrangement of the air pumps and their valves, is of the greatest importance. Many engineers are of the opinion that the more vacuum the better. There is, however, an exception with propeller engines, when the engines and air pumps are direct action. As an example, in an experiment made by the same engineer, O. E. Carlsund, he placed a small cock on the condenser; while the steam engine was working with a good vacuum he opened the cock, letting in a little air to the condenser. The number of revolutions increased from 15 to 20 per cent.; the *cause* of it, I leave to engineers for solution.

When an air pump makes more than n double strokes per minute, it does not work well, or rather works to a disadvantage. This number n, will be found by the formula

$$n = \frac{121\,\mathfrak{a}}{\mathfrak{A}\,\mathfrak{s}}\sqrt{\mathfrak{p}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (18.)$$

in which $\mathfrak{a}$ denotes the area of the valves, and $\mathfrak{A}$= area of air pump piston; $\mathfrak{s}$ being the stroke of air pump piston in feet. $\mathfrak{p}$= pressure in the condenser.

When the number of double strokes per minute are given, the area of the valve will be

$$\mathfrak{a}=\frac{n\,\mathfrak{A}\,\mathfrak{s}}{121\sqrt{\mathfrak{p}.}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19.)$$

When we get from this formula $\mathfrak{a}=\mathfrak{A}$ or $\mathfrak{a}>\mathfrak{A}$ the air pump will work with disadvantage; or when the valve $\mathfrak{a}$ is applied in the air pump piston, we only get $\mathfrak{a}=\frac{3}{8}\,\mathfrak{A}$ then, $\mathfrak{s}$ and $\mathfrak{p}$ are the only quantities which can be modified, and $\mathfrak{s}$ will be

$$\mathfrak{s}=\frac{121\,\mathfrak{a}}{n\,\mathfrak{A}}\sqrt{\mathfrak{p}.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20.)$$

In the steam engine represented on plate XIII. the valves are round and move on vertical spindles. The stroke of the air pump piston is equal to the stroke of the cylinder piston, and the diameter is 14 inches. In that case, the diameter of the valve must be calculated, and will be as follows:

$$\mathfrak{d}=\frac{\mathfrak{D}\sqrt{n\,\mathfrak{s}}}{11\sqrt[4]{\mathfrak{p}.}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (21.)$$

$$\mathfrak{d}=\frac{14\sqrt{48{\cdot}5\times 3}}{11\sqrt[4]{4}}=10{\cdot}5 \text{ inches.}$$

or, say 11 inches, as the spindle in the centre takes a few square inches. These formulæ, (18, 19, 20, 21,) undergo a little modification with different arrangements of condensers and air pumps, for instance, if the air pumps are vertical or horizontal.

In this steam engine, the air pumps have an inclination of 16 degrees to the horizon.

It is of no consequence what angle the steam engines make with each other but rather make it to suit the bottom of the vessel. There will always be angle enough for one engine to help the other over the centre, and the greater the angle the better for the friction in the bearings. With those kind of steam engines, there is sufficient room in the breadth of any vessel to get the connecting rod twice the stroke. The entire engine comes below the load line, and makes an arrangement with every convenience.

Under full motion, all the parts of the machinery are accessible for the engineer. The weight of the engines, including air pumps and condensers, will be, stationary parts, 22 tons, moving or working parts, 8 tons, total weight, 30 tons; occupying a space in the length of the vessel of only 8 feet 4 inches. Lower hold is 12 feet; on the first deck, 7 feet; on the second deck, 8 feet.

A Table of Equations Collected for Convenience and Reference.

$$P = 2{\cdot}5D\sqrt[1]{\frac{n}{n}} \quad . \quad . \quad . \quad . \quad . \quad . \quad 1.$$

$$S = \frac{\boxtimes^2 + \sqrt[3]{Q^2}}{10\,A} \quad . \quad . \quad . \quad . \quad . \quad 2.$$

$$n = \frac{200}{P\,S}\sqrt{D} \quad . \quad . \quad . \quad . \quad . \quad . \quad 3.$$

$$^{\circ}w = \frac{D\,S^2\,n^2}{200} \quad . \quad . \quad . \quad . \quad . \quad . \quad 4.$$

$$^{1}w = \frac{^{\circ}w}{2}\,(2-S) \quad . \quad . \quad . \quad . \quad . \quad 5.$$

$$^{2}w = \frac{^{\circ}w}{2}\,(2+S) \quad . \quad . \quad . \quad . \quad . \quad 6.$$

$$L = \frac{0{\cdot}6\,P}{m} \quad . \quad . \quad . \quad . \quad . \quad . \quad 7.$$

$$v = \frac{360\,L}{P} \quad . \quad . \quad . \quad . \quad . \quad . \quad 8.$$

$$^{1}v = \frac{v}{4}\,(2+S) \quad . \quad . \quad . \quad . \quad . \quad 9.$$

$$M = \frac{P\,n}{88}\,(1-S) \quad . \quad . \quad . \quad . \quad 10.$$

$$H = \frac{A\,n^2}{1950}\sqrt{P\,S} \quad . \quad . \quad . \quad . \quad 11.$$

$$a = \frac{4{\cdot}24\,n\,A\,\sqrt{P\,S}}{p\,s\,(1-f)} \quad . \quad . \quad . \quad 12.$$

$$d = \sqrt[3]{\frac{94\,n\,A\sqrt{P\,S}}{p\,(1-f)}} \quad . \quad . \quad . \quad 13.$$

$$H = \frac{a\,p\,s\,n}{33000}\cdot 4\,(1-f) \quad . \quad . \quad 14.$$

$$Coal = \frac{c\,n}{x\,k} \quad . \quad . \quad . \quad . \quad . \quad 15.$$

$$\mathfrak{D} = 8{\cdot}15\sqrt{D\,P\,S} \quad . \quad . \quad . \quad 16.$$

$$\delta = \sqrt{D^2 + 1{\cdot}2\,s^2} - 1{\cdot}1s \quad . \quad . \quad 17.$$

$$n = \frac{121\,\mathfrak{a}}{\mathfrak{A}\,\mathfrak{s}}\sqrt{\mathfrak{p}} \quad . \quad . \quad . \quad . \quad 18.$$

$$\mathfrak{a} = \frac{n\,\mathfrak{A}\,\mathfrak{s}}{121\sqrt{\mathfrak{p}}} \quad . \quad . \quad . \quad . \quad . \quad 19.$$

$$\mathfrak{s} = \frac{121\,\mathfrak{a}}{n\,\mathfrak{A}}\sqrt{\mathfrak{p}} \quad . \quad . \quad . \quad . \quad 20.$$

$$\mathfrak{d} = \frac{\mathfrak{D}\sqrt{n\,\mathfrak{s}}}{11\sqrt[4]{\mathfrak{p}}} \quad . \quad . \quad . \quad . \quad . \quad 21.$$

$$p = \frac{4{\cdot}24\,n\,A\sqrt{P\,S}}{a\,s\,(1-f)} \quad . \quad . \quad . \quad 22.$$

$$n = \frac{a\,p\,s\,(1-f)}{4{\cdot}24\,A\sqrt{P\,S}} \quad . \quad . \quad . \quad 23.$$

$$S = 1 - \frac{88\,M}{P\,n} \quad . \quad . \quad . \quad . \quad 24.$$

$$P = \frac{200}{S\,n}\sqrt{D} \quad . \quad . \quad . \quad . \quad 25.$$

$$P = \frac{360\,L}{v} \quad . \quad . \quad . \quad . \quad . \quad 26.$$

$$P = \frac{\pi\,D\,L}{e} \quad . \quad . \quad . \quad . \quad . \quad 27.$$

$$P = \frac{\pi\,D\,L}{\sqrt{b^2 + L^2}} \quad . \quad . \quad . \quad . \quad 28.$$

$$P = \cot.\,V\,\pi\,D \quad . \quad . \quad . \quad . \quad 29.$$

$$\cot.\,V = \frac{P}{\pi\,D} \quad . \quad . \quad . \quad . \quad 30.$$

D = Diameter of the Propeller in feet.
P = Pitch.
L = Length of the Propeller in feet.
A = Area in square feet.
S = Slip in decimal fractions.
m = Number of Blades in the Propeller.
n = Number of Revolutions per minute.
b = Extreme Breadth of the Propeller Blade over its extremity in feet.
e = Length of the Circle Arc in the angle v in feet.
$\otimes^2$ = Transverse Sectional Area of Displacement.
Q = Displacement in tons.
$^{\circ}w$, ^{1}w, ^{2}w, v, ^{1}v, and V = Angles in degrees of a Circle.
M = Statute miles per hour.
H = Actual horse power.
a = Area of the Piston in square inches.
d = Diameter of Cylinders in inches, when there are two direct action Cylinders, and stroke of Piston $d = 1{\cdot}5s$.
p = Effectual Pressure on the Piston per square inch, including the vacuum.
s = Stroke of Piston in feet.
c = Cubic feet of Steam for each revolution.
k = Volume of Steam compared with Water.
x = Coefficient of Water evaporated per pound of coal per hour.
f = Friction and working the Pumps, per cent.
Coal = Anthracite, in tons, per hour.
$\mathfrak{A}$ = Area of the Air Pump Piston.
$\mathfrak{a}$ = Area of the Air Pump Valve.
$\mathfrak{D}$ = Diameter of Air Pump Piston.
$\mathfrak{d}$ = Diameter of Air Pump Valve.
$\mathfrak{s}$ = Stroke of Air Pump Piston.
$\mathfrak{D}$ = Diameter of Propeller Shaft.
$\mathfrak{d}$ = Diameter of Crank Pin.
$\mathfrak{p}$ = Pressure in the Condenser.

Table for Finding the Pitch of Propellers.

By this table (plate XIV.) the pitch of a propeller can be found in an instant, with any diameter and angle of the propeller blades, between 45° and 70°. The degrees will be found on the circular arc; the diagonals show every tenth minute where the pitch arm crosses the same at *a*.

The pitch will be found on the pitch-arm, where the diameter lines cross the same, when set on a given angle at *a*. If the angle is to be found, when the diameter and pitch are given, move the pitch-arm until the given pitch crosses the given diameter line; the corresponding angle will be found at *a*.

Propeller makers not fully acquainted with the theory of the propeller, will sometimes find it difficult to lay out the propeller with a certain pitch, or when a few dimensions are given, to ascertain the pitch; for that purpose there are some tables, which will probably meet with their approbation, for convenience in practical use.

When the centripetal propeller has been fully tested by experiment, it is intended to publish a small work, containing those Tables, and directions relating to propellers in general.

As the screw propeller is the most valuable instrument for the propelling of vessels, and thus far, behind the paddle wheels in the employment of steam for propelling, its friends therefore, ask for the screw propellers and their engines, that they should be submitted to a series of patient and impartial experiments; extending through two or more different vessels, and six or more different propellers. These experiments I feel confident, will result in *proving its equality* to paddle wheels, and as the screw propeller (if rightly made,) is a direct action propelling instrument, as well as the paddle wheels, why should the preeminence be justly on the side of the latter?

Experiments, we know, have been made again and again, but the principal feature has been too often overlooked.

In reference to propeller engines with gearings, it is worthy of inquiry what *is gained by them?* If they are intended to increase the number of revolutions of the propeller, we see where ever they are applied, that they do not. They only increase the size, weight, and expense, and occupy more room in the vessel. Propellers with equal diameter and pitch, will make rather more revolutions from a direct action steam engine with the same quantity of steam.

The mechanical law says, "*Apply the power as near the object as possible.*" And the words *stationary* and DIRECT ACTION, (no trunks,) are perfect teachers on the subject.

Philadelphia, September, 1851.

Translated for the Journal of the Franklin Institute.

Experiments on the Application of Electro-Magnetism as a Motive Force.

By M. ARISTIDE DUMONT.

The author announces in the following terms, the consequences to be deduced from the experiments reported in his memoir:

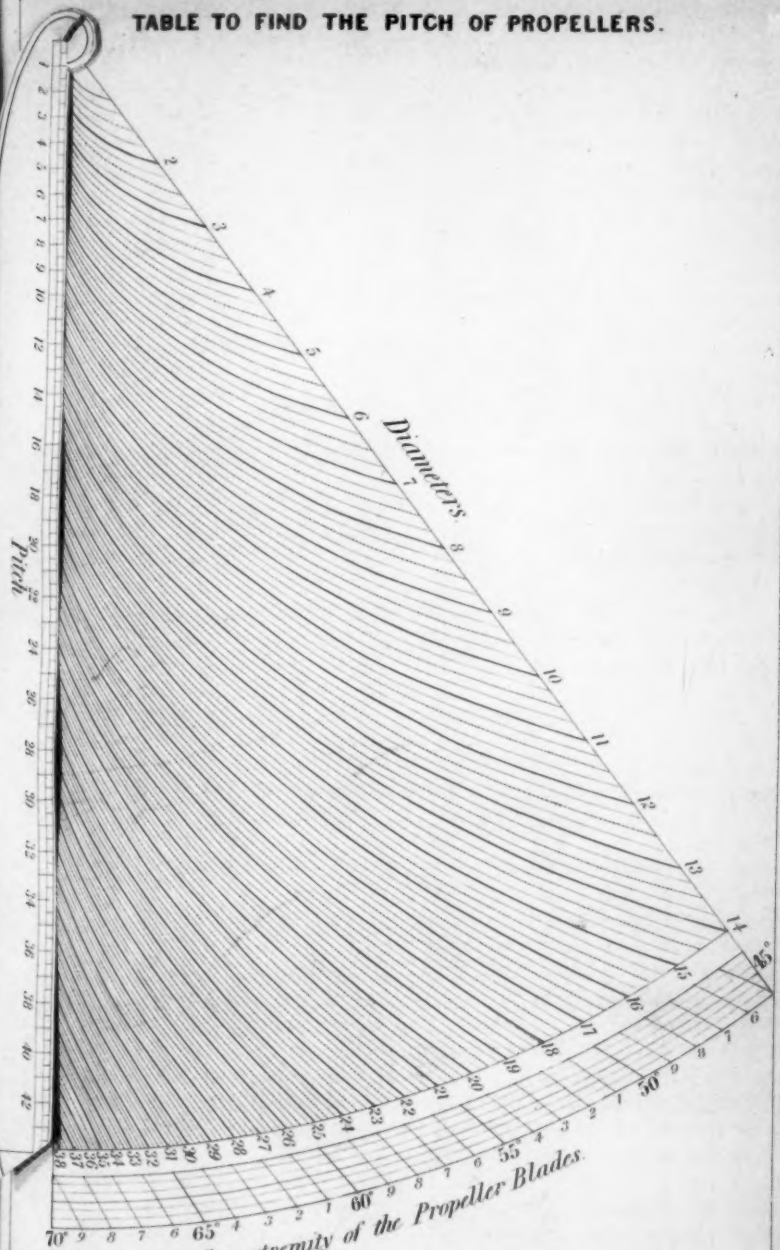
1. The electro-magnetic force, although it cannot yet be compared to the force of steam in the production of great power, either as it regards the absolute amount of power produced, or the expense, may nevertheless, in certain circumstances, be usefully and practically applied.

2. While in the development of great power, the electro-magnetic force is very far inferior to that of steam, it becomes equal and even superior to it in the production of small forces, which may be thus subdivided, varied, and introduced into trades and occupations using but small capitals, where the absolute amount of mechanical power is less exerted than the facility of producing it instantaneously and at will.

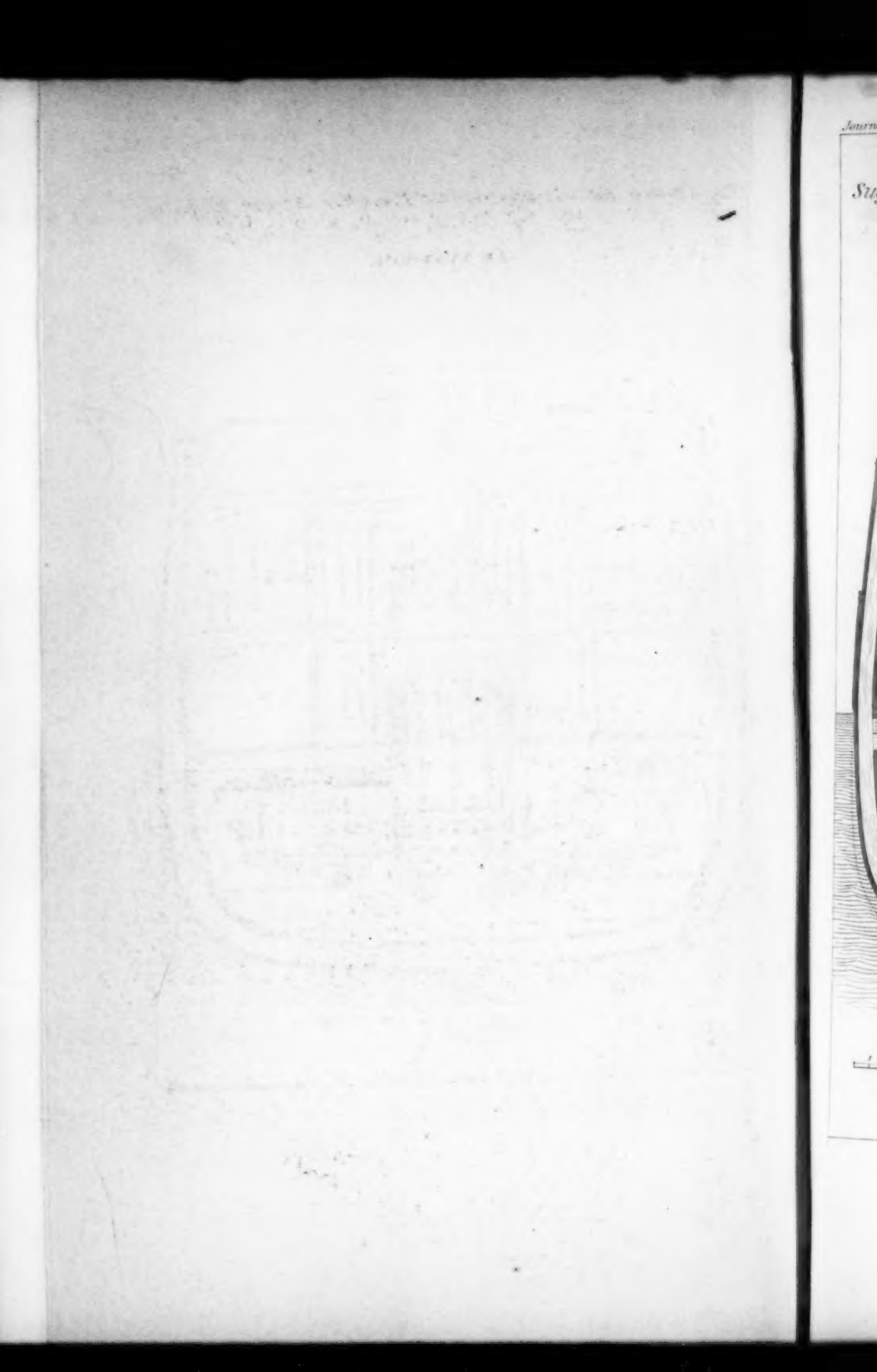
3. In this point of view, the electro-magnetic force assists, as it were, the usefulness of steam, in place of uselessly competing with it.

4. Other things being proportional, electro-magnetic machines with direct alternating movement, present a great superiority of the power developed over rotating machines; since in the first there are no compo-

TABLE TO FIND THE PITCH OF PROPELLERS.



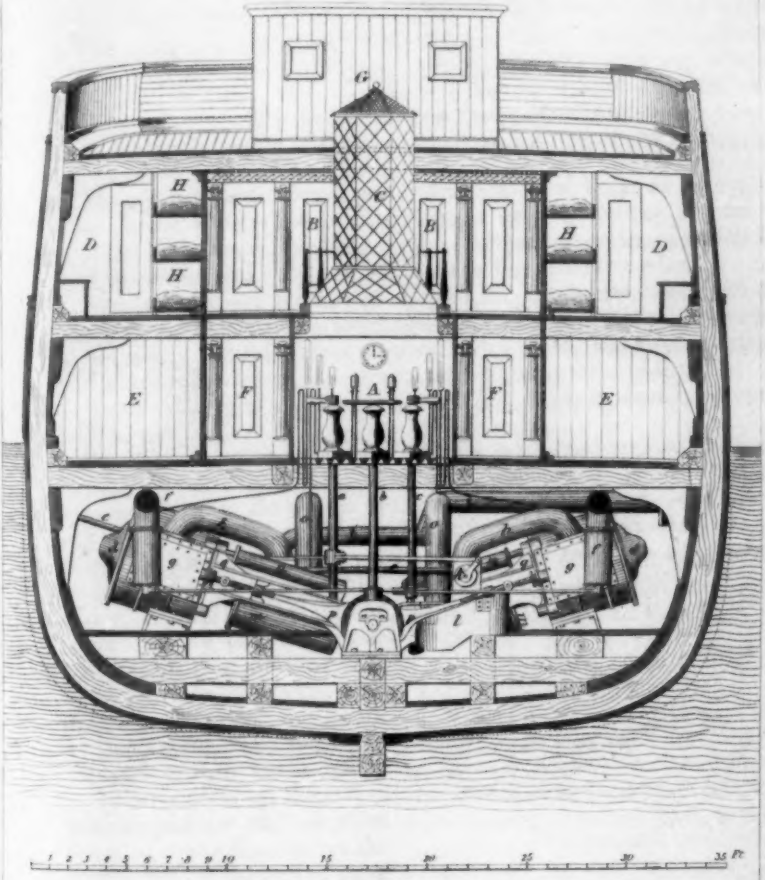
J.W.Nystrom, del.



Suggestions for arrangement of Propeller Steam Engines

by

J.W. NYSTROM.



nents lost, and with the same expense a much more considerable power is obtained than with rotating machines.

5. In machines of direct movement, the influence of the currents of induction appears less considerable than in rotating machines.

6. Finally, in the calculation of the expense, it is proper to include deduction of the value of the sulphate of zinc produced, and to take into consideration, that in apparatus of any considerable size, the same battery may be used at the same time for the production both of the power and light.—*Comptes Rendus de l'Academie des Sciences, Paris, August* 25, 1851.

For the Journal of the Franklin Institute.

On the Gain of Power by Centrifugal Force. *By* T. W. Bakewell.

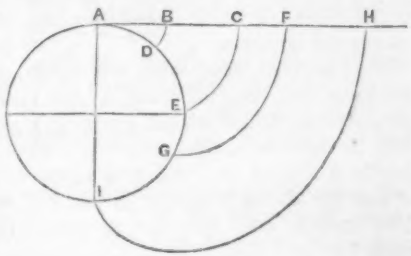
The recent controversy, particularly in New York, as to centrifugal force being susceptible of furnishing a gain of power by machinery adapted to that end, has induced the following remarks, in which I have endeavored to make the subject plain to the general reader.

Suppose a wheel in a horizontal position, the axis vertical, with hollow arms closed at the ends, and having a heavy ball in each, free to move in the arm. Let this wheel revolve with a given velocity, and the balls will press with a certain force against the ends of the arms.

If the velocity of the wheel be doubled, the ball pressure on the ends will be quadrupled.

Herein is the supposed gain; and it is my object to show it deceptive, and of no practical avail. When the wheel is under the first named velocity, imagine the end of the arm suddenly removed:—the ball would not then fly outward in the direction of its previous pressure, but be projected at a tangent to the wheel, as from A to B, in a given time.

Under the double velocity, (the end of the arm being removed as above,) the ball would not fly outwards, in the direction of its previous quadruple pressure against the end, but would be projected to C, twice the distance of B, in equal time.



This result, is by the law of centrifugal force, and all other forms of dynamics, viz: in the simple ratio of the power used.

The quadruple pressure by the ball, under double velocity, is in this wise:—The ball, in revolving, has, at any and every point of the circle, a velocity in a tangential direction, as A to B, but is coerced from this straight line, by the closed end of the arm, compelling the ball to follow the circle, thus causing the pressure on the end; and the ball is found at D, instead of B, having been coerced from its straight line by a force, represented the by curved line B D.

In like manner under double velocity, the ball is found in equal time,

at E instead of C; but then the force to coerce the ball from its (pre-induced) straight line, is represented by the curved line C E which is the quadruple of B D and has thus caused a quadruple pressure on the end of the arm.

These curves (involutes) may be formed by a thread, fast at A, and stretched along the line to B or C, brought down with a marking point to D or E, the thread winding round and against the edge of the circle. The curves are, at every part, perpendicular to a tangent of the circle, and truly represent the intensity of the required force by their length, and the varied direction, by their form, to overcome the tangential impulse, and are as the squares of the projectile velocities.

If the hollow arms of the aforesaid wheel were open at the ends, the ball being introduced near the centre, the rotation of the wheel would impel the ball outwards, by a continued effort of the ball to pursue the tangential directions, *which alone* is the cause of an apparently direct outward impulse, and the ball would leave the end of the arm under the last tangential direction and velocity, modified only by the outward motion acquired in its progress from the centre; and the velocity of this modified tangential projection of the ball would be in the direct ratio of the power used, as in the case previously cited.

Again, if to the end of the hollow arm be joined an elbow turning upwards, and a liquid, as water (or quicksilver,) be supplied at the centre, the water would rise in the upright part, in the ratio of the squares of the velocities, presenting the plausible aspect of a discharge, if taken from the bottom of the upright, being in quantity what would be due to the head.

But the flow of water, from the centre outward, being caused *alone* by the tendency to pursue a tangential direction (as in the case of the ball) —the supply to the discharge at the bottom of the upright would be in the direct ratio of the tangential velocity. The barren, passive, outward pressure at the end, or centrifugal force, never gives motion to any object in its own outward direction—but merely sustains and swerves the tangential impetus.

If in a given time, with any circle, the projectile and constant force be such that, starting from A, the ball would be impelled to a distance proportional to the circle, equal to F on the straight line, or to G if rotating in the circle, the centrifugal force F G, would be equal to the projectile A F or A G—and both equal to the diameter A I.

Let the above projectile force, A F or A G, equal gravity; the distance 193 inches, and time one second,—the diameter A I being also 193 inches.

Then, a wheel of 193 inches diameter, whose circumference moves at the rate of 193 inches in one second revolves in 3·1416 seconds, and has the centrifugal force equal to gravity.

Retaining the above circle:—If the projectile force, or the distance attained by it in a given time be greater in proportion to the circle, than A F or A G as A H or A E I,—the centrifugal force will be greater than the projectile, as curve H I, 476·208 is greater than line A H, or arc A E I, 303·164.

If the proportional projectile force, or distance attained, be less than

A F or A G, as A C, the centrifugal force will be less than the projectile, as curve C E, 119·052, is less than A C or A E, 151·582.

But in all cases the *ratio* of increase, or decrease, of the centrifugal forces (represented by the curves) is as the squares of the projectile velocities.

Cincinnati, October, 1851.

For the Journal of the Franklin Institute.

A Series of Lectures on the Telegraph, delivered before the Franklin Institute. Session, 1850–51. *By* Dr. L. Turnbull.

Continued from page 266.

Steinheil's Electro-Magnetic Needle Printing Telegraph.

The next telegraph in order of date of publication is that of Professor Steinheil, the first published notice of which I find in a letter from Munich, dated December 23d, 1836, published in the third volume of the *Magazine of Popular Science.*

"Prof. Steinheil has fitted up a telegraph here according to the plan of Prof. Gauss, and similar in principle to that, which connects the Observatory and Cabinet of Natural Philosophy at Göttingen." This telegraph was in operation previous to July, 1837, but was not published and described until August, 1838. "His Memoir was communicated for the *Comptes Rendus*, July 19, and published in September, 1838. According to the authority of Prof. Morse, Steinheil's telegraph was adopted by the Bavarian Government, and was in actual operation during his visit to Europe in 1838. According to the same authority, in 1838, "Professor Steinheil's telegraph was the only European telegraph that professed to write the intelligence. See Letter of Professor Morse to the Hon. C. G. Ferres, *Vail's Electro-Mag. Telegraph*, pp. 95, 97.

In the work of Dr. Schellen, published in Germany in 1850, it is stated that Steinheil's telegraph was in operation in 1837.

This is the first telegraph which I find on record, in which the earth was employed as half of the circuit—a most useful application of knowledge, gained at great labor, and not patented, but published freely to the world. His experiments are thus described by Dr. Schellen, in his work on the telegraph:

"Gauss had already conceived it possible to make conductors of the rails of a railroad, when Steinheil, in 1838, made the experiment, insulating the chairs of the rails by tarred felt; this was, however, imperfect insulation, as the circuit would not extend beyond thirty rails. To test the matter more thoroughly, he had some new rails constructed; but the points of contact were so numerous, and the establishment of a metallic connexion between the two rails by the wheels and axles of the cars passing over them so complete, that the current lost its force, and all idea of the measure was given up. This experiment demonstrating the conducting power of the earth, induced Steinheil to think of that as a means of return circuit, and thus dispense with one-half the wire. The fact by experiment he found verified, and immediately arranged his apparatus on this plan. This was

a discovery of vast utility, and has contributed much to the extension of telegraphing. Steinheil says, you can make conductors of earth and water, as well as of wire, if you increase their size in proportion to the non-conductibility of the substance. Water was 100,000 times worse as a conductor than copper, and therefore the conducting surface should be made 100,000 times greater; in order to obtain this large conducting medium, it is necessary that the wires should terminate in submerged plates of the re-quired dimensions to include that medium between them. The same idea was afterwards brought forward by Dr. Cox, of this city, in regard to the use of railroads for telegraphic purposes, in September, 1845.

Steinhiel's alphabet is one of great beauty and simplicity, displaying the man of learning and refinement; as, for example, his musical bells, producing sounds which, striking upon a cultivated ear, conveyed a telegraphic language in imitation of the human voice. But he did not confine himself to the production of evanescent sound, he also employed the simple dot, so as to fix them permanently upon paper, that they could be recalled again. This form of telegraph is a combination of the successive fundamental discoveries of Professors Œrsted and Faraday, with the multiplicator of Schwigger.

I extract from the original paper of Steinheil, published in the *London Annals of Electricity*, March and April, 1839, an account of his telegraph, being the most complete which I can find on record:—

To Gauss and Weber* is due the merit of having in 1833, actually constructed the first simplified galvano-magnetic telegraph. It was Gauss who first employed the excitement of induction, and who demonstrated that the appropriate combination of a limited number of signs is all that is required for the transmission of communications. Weber's discovery that a copper wire 7460 feet long which he had led across the houses and steeples at Göttingen from the observatory to the cabinet of Natural Philosophy required no especial insulation was one of great importance. The principle was thereby at once established of bringing the galvanic telegraph to the most convenient form. All that was required was an appropriate method of inducing or exciting the current with the power of changing its direction without having recourse to any special contrivances for that purpose. In accordance with the principles we have laid down, all that was required in addition to this was to render the signals audible, a task that apparently presented no very particular difficulty, inasmuch as in the very scheme itself a mechanical motion, namely, the deflexion of a magnetic bar, was given. All that we had to do therefore was to contrive that this motion should be made available for striking bells or for making indelible dots. This falls within the province of mechanics, and there are therefore more ways than one of solving the problem. Hence the alterations that I have made in the telegraph of Gauss and by which it has assumed its present form may be said to be founded on my perception and improvement of its imperfections, in harmony with what I had previously laid down as necessary for perfect telegraphic communication. I by no means however look on the arrangement I have selected as complete; but as it answers the purpose I had in view, and it may be well to abide by it till some simpler arrangement is contrived.

*Gott. gel. Anz. 1834, p. 1273, and Schumacher's Jahrbuch, 1837, p. 38.

As an inductor or exciter I employ a rotating apparatus whose construction, speaking in a general way, is similar to those of Clarke, of London. The multipliers of which my inductor is composed, consist of a vast number of turns of fine insulated copper wire; and this arrangement is necessary in order that the resistance offered by the thicker wire completing the circuit, even should it be many miles long, may be but little increased. Of the galvanic influence excited during the entire half-turn of the rotating double multiplier, only a small portion is employed, and that when it is at the maximum of its energy. By this means the duration of the current is but very short, an arrangement which therefore, in a manner, can cause merely a momentary deflexion of the little magnetic bars employed for giving the signals. In order to heighten the action of these indicators as much as possible, they are surrounded by powerful multipliers. Small detached magnets are so placed near these indicators, that they are thereby brought back to their original position immediately that the induced current ceases, or in other words, as soon as the deflexion has taken place: I thus am enabled to repeat signals in very rapid succession. The same indicator can be brought with ease to make five deflexions in a second, succeeding each other as fast as the sounds of a repeater when striking. Hence if bells are placed at the proper striking distance from these indicators, they will ring at every deflexion produced, and as it is quite immaterial at what part of the wire, completing the circuit, the multiplier containing the indicator is inserted, we have it in our power to produce the sign excited by induction at any part of the course the wire takes. Should it be desired that the indicator instead of producing sounds should write, it is merely required to adapt to one end of the little magnetic bar a small vessel filled with a black color, and terminating in a capillary tube. This tube, instead of striking on a bell, thus makes a black spot upon some flat surface held in front of it. If these spots are to compose writing, the surface upon which they are printed must keep moving on in front of the indicator with a uniform velocity, and this is easily brought about by means of an endless strip of paper which is rolled off one cylinder on to another by clockwork. This is in a general way the construction followed in the telegraph erected here, a fuller account of which now would be out of place, as it may be found on referring to the appendix. As far as the employment of this telegraph is concerned, it may be fairly said to perform all that can be reasonably required of it. The excitation of the current is produced by half a turn of the indicator, and is equally available at all times. The sounds of the bells close to the person making the signals, and which being produced at the other station too are also audible there, become, by practice, intelligible as a language. Should they, however, be overheard or misunderstood, the communication presents itself simultaneously written down. This can be done with closed doors, without any but the parties concerned being aware of it: the communications may be made at any distance, and either by day or night, without any appreciable loss of time. There is, therefore, every reason to be content with the performance of the instrument.

It is not, however, to be denied, that the establishment of certain con-

ditions indispensable to its action is, nevertheless, a matter of some difficulty. We allude to the connecting wire joining the stations.

It has been stated above that Ampere required more than sixty such wires, whereas thirty or so were sufficient for Sömmering. Wheatstone and Cooke* reduced their number to five; Gauss, and, probably in imitation of him, Schilling, as likewise Morse† in New York, made use of but a single wire running to the distant station and back. One might imagine that this part of the arrangement could not be further simplified, such, however, is by no means the case. I have found that even the half of this length of wire may be dispensed with, and that with certain precautions its place is supplied by the ground itself. We know in theory that the conducting powers of the ground and of water are very small, compared with that of the metals, especially copper. It seems however to have been previously overlooked, that we have it within our reach to make a perfectly good conductor out of water or any other of the so called semi-conductors. All that is required is, that the surface that its section presents should be as much greater than that of the metal as its conducting power is less. In that case the resistance offered by the semi-conductor will equal that of the perfect conductor; and as we can make conductors of the ground of any size we please, simply by adapting to the ends of the wires, plates presenting a sufficient surface of contact, it is evident that we can diminish the resistance offered by the ground or by water to any extent we like. We can, indeed, so reduce this resistance as to make it quite insensible when compared to that offered by the metallic circuit, so that not only is half the wire spared, but even the resistance that such a circuit would present is diminished by one-half. This fact, the importance of which in the erection of galvanic telegraphs speaks for itself, furnishes us with another additional feature in which galvanism resembles electricity. The experiments of Winkler, at Leipzig, had already shown us that with frictional electricity the ground may replace a portion of the discharging wire. The same is now known to hold good with respect to galvanic currents.

The enquiry into the laws of dispersion, according to which the ground, whose mass is unlimited, is acted upon by the passage of the galvanic current, appeared to be a subject replete with interest. The galvanic excitation cannot be confined to the portions of earth situated between the two ends of the wire; on the contrary, it cannot but extend itself indefinitely, and it became, therefore, now only dependant on the law that obtained the excitation of the ground and the distance of the exciting terminations of the wire, whether it was necessary or not to have any metallic communication at all for carrying on telegraphic intercourse.

I can here only state in a general way that I have succeeded in deducing this law experimentally from the phenomena it presents: and that the result of the investigation is, that the excitation diminishes rapidly as the distance between the terminal wires increases.

An apparatus can, it is true, be constructed in which the inductor, having no metallic connexion whatever with the multiplier, by nothing more than the excitation transmitted through the ground, will produce

* La France Industrielle, 1838, April 5, p. 3.

† Mechanics' Magazine, No. 757, p. 332. Silliman's Journal for October, 1837. Annals of Electricity, &c., Vol. II. p. 116.

galvanic currents in that multiplier sufficient to cause a visible deflexion of the bar. This is a hitherto unobserved fact, and may be classed upon the most extraordinary phenomena that science has revealed to us. It only holds good, however, for small distances. It must be left to the future to decide whether we shall ever succeed in telegraphing at great distances without any metallic communication at all. My experiments prove that such a thing is possible up to distances of 50 feet. For distant stations we can only conceive it feasible by augmenting the power of the galvanic induction, or by appropriate multipliers constructed for the purpose, or, in conclusion, by increasing the surface of contact presented by the ends of the multiplier. At all events the phenomenon merits our best attention, and its influence will not perhaps be altogether overlooked in the theoretic views we may form with regard to galvanism itself.

To sum up in a few words what are the results of what we have here brought forward respecting telegraphic communications, we see that, with the present arrangement of the apparatus, no principle can be brought into competition with the galvanic telegraph, but that the establishing the metallic connexion indispensable to its action, although now materially simplified, still presents great difficulties in practice. Indeed, such a connexion is only practicable where it can be constantly watched, as, for instance, in the vicinity of railroads.

For very considerable distances without intermediate stations, galvanic or electric excitation must, on account of their rapidity, be always the best power to have recourse to. For less distances it yet remains open to enquiry whether, with proper modifications, some of the other methods we have pointed out would not be preferable, as they dispense with a metallic connexion.

To be Continued.

For the Journal of the Franklin Institute.

Trial Trip of the U. S. Screw Propeller Steamship of War, San Jacinto. By Chief Engineer B. F. Isherwood, *U. S. Navy.*

This fine war steamer has just been completed and her trial trip made. A correct account of the vessel and her performance will be of general interest, and also professionally valuable.

The "San Jacinto" is one of the four steamships of war commenced by the U. S. Government in 1847, viz: the "Powhattan," "Susquehanna," "Saranac," and "San Jacinto;" all of which, with the exception of the first named, have been completed. With the exception of the last named, they all have the common paddle wheel. The "Saranac" and "San Jacinto," are of precisely the same dimensions and model, the intention of the government being to make the two vessels as nearly identical as possible, in order to try the relative merits of the two systems of propulsion.

It was originally contemplated to use for the stern arrangement, a *combination* patented by Ericsson, in 1849, the claim on which is as follows:

"What I claim as my invention and desire to secure by letters patent

is, the above described location or arrangement of the propeller shaft, in combination with the rudder made with a slot or recess to admit of the play thereof, substantially in the manner and for the purpose specified."

Which purpose and manner is specified in the said patent as follows:

"Prior to my invention the leading objections to the use of a propeller at the stern of a ship, was the weakening of the ship by cutting the stern to form a recess for the propeller forward of the rudder, and thus carrying the stern post or the part with which the rudder is connected so far back as greatly to reduce the stability of the structure. To avoid this, the use of two propellers, one on each side of the run of the ship, was essayed, but this is well known to be even more objectionable, as the shafts in that case must pass out through the run of the ship so far from the stern post and keelson, to have sufficient room between the axis of the propeller and the run of the ship for the semi-diameter of the propellers, as greatly to strain the ship, and requiring, in addition to the complexity consequent on two propellers, outriggers at the sides for the support of the projecting part of the shafts, which for sea purposes is highly objectionable.

"Another serious objection was, the difficulty of access to the propeller for the purpose of repairs, and the resistance presented by it when sailing alone.

"To obviate these and other minor objections not necessary to enumerate was the object of my invention, the principle or character of which consists in passing the shaft of the propeller through the run of the ship, and by the side of the stern post, that one of the bearings may be attached thereto for strength and stability, the propeller being placed abaft the rudder, and as this location of the shaft would of necessity interfere with the play of the rudder, this part of my invention consists in combining the location of the shaft and propeller with the rudder made with a slot commencing at the outer edge, that it (the rudder) may have the requisite play."

The above arrangement was so far from being a novelty or invention by Ericsson, that it was proposed to the French Minister of Marine in a memoir addressed to him in 1841, by the Commandant, Henry Labrousse, and printed in 1843. On page 75 of the appendix to this memoir, under the head of Hull, will be found the following:

"Si le faux étambot était en bois, il faudrait, pour qu'il ne fût pas affaibli outre mesure, par l'ouverture nécessaire au passage de l'arbre, lui donner une épaisseur considerable, ce qui nuirait à l'action de la vis et à la marche, par suite du remous occasionné en arrière; on pourrait néanmoins faire passer l'arbre tangentiellement à l'un des cotes du massif."

Which I translate literally as follows:

"If the false stern post were of wood, it would be necessary, in order that it be not too much weakened by the hole for the passage of the shaft, to give it considerable thickness, which would be injurious to the action of the screw and the speed, (of the vessel,) by reason of the eddy caused astern; one could, nevertheless, pass the shaft tangentially by one of the sides of the dead wood."

It may also be as well to remark *en passant*, that the use of *two* propellers was never proposed, except for vessels of very light draft proportion-

ally to their displacement, and then the reason for using them was, to obtain sufficient propelling surface; furthermore, the passing of the propeller shaft through the dead wood of the vessel, tangentially by the side of the stern post, weakens the stern of the vessel quite as much as passing the shaft through the stern post, while the serious inconvenience follows, of throwing the engines and shaft of the propeller out of the centre of the ship. In the "San Jacinto," the axis of the propeller shaft is 20 inches to port from the centre of the ship.

The foregoing plan of Ericsson's was persevered in by the late engineer in chief of the Navy, Chas. H. Haswell, who designed the boilers, engines, and propeller, (proposed not executed propeller,) as late as December last, when he was superseded by the present Engineer in Chief, General Chas. B. Stuart, who disapproving the propeller and general stern arrangement of the vessel, which was not then completed, though the engines and boilers were finished and in their places; a Board of Chief Engineers of the Navy was ordered by the Navy Department, to examine the vessel and propose whatever modification they deemed judicious. The report of this board fully sustained, *seriatim*, the objections of Gen. Stuart, and proposed the present plan of stern arrangement and propeller, which was at once executed.

In this arrangement the propeller (of entirely different proportions from that designed by Mr. Haswell) was placed next the stern post of the vessel, and a metallic rudder was curved over and abaft the propeller, being attached to the stern post above and below the propeller. The invention of this stern arrangement was made by myself and adopted by the board.

Engines.—The engines consist of two inclined cylinders with vertical air pumps; the cross heads, being placed at the upper extremity of the cylinders, are connected to a double set of cranks by two connecting rods to each cross head. The engines are connected by drag links.

The cylinders are 62½ inches diameter and 4 feet 2 inches stroke of piston. Space displacement of both pistons per stroke, 179·54 cubic feet.

Cost of Engines, (exclusive of boilers and propeller,) . .	$105,247
Total breadth occupied by engines, between extreme points, . .	29 feet.
Total length, " " " " . .	23 1-6
Total height from centre shaft to top of steam pipe, . . .	9½

Boilers.—The boilers are of copper and three in number; they contain in the aggregate, 195½ square feet of grate, and 5250 square feet of heating surface. They are of the double return drop flue variety. Cross area or calorimeter of first flues, 35 square feet; of second flues 35 square feet; of third flues, 32 square feet; area of smoke chimney, 34 square feet; height of ditto above grate, 65 feet; proportion of heating surface per cubic foot of cylinder, 17¾ square feet; aggregate weight of copper in the three boilers, 214,575 pounds; cost of ditto, $53,054·56; cost of labor on boilers, $39,705·53; making the total cost of boilers, $92,760·09.

The different kinds of copper were furnished in the following quantities and prices:

157,892	pounds of	plates at . . .	28	cents per	pound
38,386	"	bolts " . . .	25	"	"
18,297	"	rods " . . .	25⅞	"	"

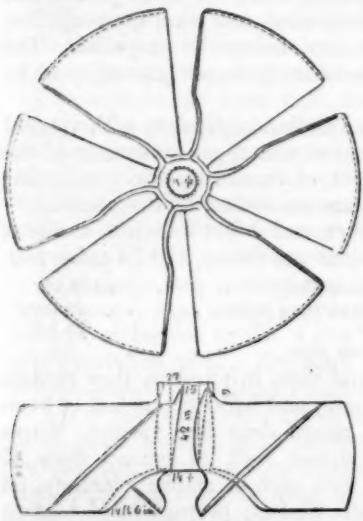
The three copper boilers of the "Saranac," containing 5127 square feet of heating, and 188 square feet of grate surface, designed by Chas. W. Copeland, contained the following quantities of copper at the annexed prices:

137,703	pounds of plates at	. . . .	28	cents per pound
28,331	" bolts "		25	" "
27,927	" rods "		26	" "
Total, 193,961 pounds.				

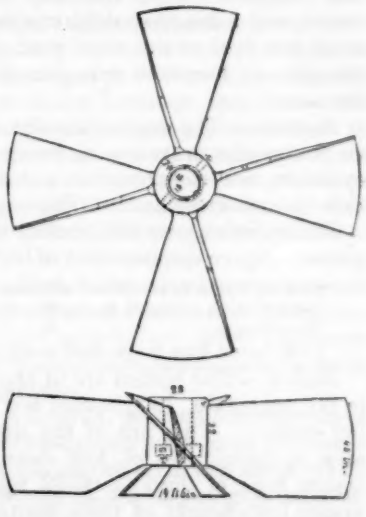
The boilers of the "Saranac" are of the same length, breadth, and height as those of the "San Jacinto;" cost of materials in the boilers of the "Saranac," $53,150·27; of labor on ditto, $23,747·55, making their total cost, $76,897·82, or $15,882·27 *less* than those of the "San Jacinto."

Propeller.—The propeller originally designed by Mr. Haswell, and condemned by the board of Chief Engineers, was 14½ feet diameter, 4¾ feet long on axis at periphery, with an initial pitch of 35 feet, expanding to 40 feet at the posterior end. The area, viewed as a disk, was 115½ square feet. The helicoidal area was 399 square feet; number of blades, six.

Screw Propeller originally proposed to be used. Initial pitch 35 feet, expanding to 39 feet.



Screw Propeller used. Initial pitch 40 feet, expanding to 45 feet.



The propeller recommended by the board and executed for the vessel, was 14½ feet diameter, 4 feet long on axis at periphery, 4 feet long on axis, at a diameter of 7½ feet, thence tapering to 2½ feet long on axis at hub, with an initial pitch of 40 feet, expanding to 45 feet at the posterior end. The area viewed as a disk was 65·48 square feet. The helicoidal area was 112,677 square feet; number of blades, four; space between the front edge of the propeller and the stern post of the vessel, (left for the rudder,) 6 feet.

The reason why the board recommended the increased pitch was, that

the engine would, with that pitch, consume all the steam that the boilers could generate, cutting off at one-third the stroke of piston from the commencement; while the complex design, with the numerous joints and connexions of the engines, rendered it unsafe to work them at the velocity required in order to make the proper speed of the vessel, with the lower pitch of Mr. Haswell. The reduction in length was for the purpose of diminishing the surface of the screw, practice and theory both demonstrating the posterior portion of the blade to be of small efficiency compared to the anterior portion. In Mr. Haswell's propeller, a large portion of the surface of each blade overlapped or re-acted on the one following, which portion was useless for propulsive effect, and detrimental from its friction on the water. The six blades of Mr. Haswell's propeller were too numerous, not allowing sufficient space for solid water to enter between them, being as objectionable in this respect as too many paddles in a common paddle wheel, where it is well known, that with the usual proportions, each alternate paddle can be left out without sensibly increasing the slip of the wheel. Besides, with the 6-bladed propeller, there is encountered one-half more direct resistance from the thickness of the advancing edges of the blades, than with the four bladed propeller, and the six blades have also one half more resistance to overcome from the *adhesion* of the water to be divided by the blades. That this latter resistance is considerable, is proven by the experiments of Faraday, who ascertained "that the cohesive force of every square inch of water is equal to several hundred pounds."

The alteration of the relative positions of the rudder and propeller, was for the purpose of diminishing the leverage of the propeller weight on its shaft and on the stern of the vessel, as it had no outboard support. These were the principal reasons that controlled the board in their proposed changes. The board also estimated the slip of their propeller at 22 per ct.

The weight of the bronze propeller as cast and placed in the vessel, is 14,894 pounds; cost of ditto, $7,457.

The weight of the Stevens' bronze propeller for the U. S. Steamship, "Princeton" was 15,970 pounds. It was 14¼ feet diameter, 5 feet long on axis at periphery, and composed of 6 blades, having a pitch of 32·44 feet.

Performance.—The "San Jacinto" being brought to a draft of 15 feet 7 inches forward, and 15 feet 9 inches aft, was tried in New York Bay, Oct. 1, 1851. She made, in running a distance of 17¾ statute miles, taken from the chart published by the U. States Survey Office, 9·95 statute miles per hour against a strong wind on the port bow, estimated by the experienced pilot on board, as equivalent to a reduction of speed of one mile per hour. The tide was about slack at starting, but toward the close was ahead. The speed of the vessel in smooth water and a calm would therefore be 11 statute miles per hour. Mean revolutions of the screw per minute, 31.

With the initial pitch of the screw 40 feet, the slip would be as follows:

40×31×60=74,400	feet per hour	=speed of screw.
5280×11=58,080	"	=speed of vessel.
16,320	"	=slip of screw.

or 21·935 per cent.

With the final pitch of the screw 45 feet, the slip would be as follows:

$45 \times 31 \times 60$	83,700 feet per hour	=speed of screw.
5280×11	58,080 "	=speed of vessel.
	25,620 "	=slip of screw.

or 30·609 per cent.

The mean slip would therefore be $\frac{21{\cdot}935 + 30{\cdot}609}{2} = 26{\cdot}27$ per cent.

The mean effective steam pressure on the pistons, by indicator diagrams taken from top and bottom of each cylinder, was 16·29 pounds per square inch, the horse power developed by the engines would therefore be as follows:

$$\frac{3067{\cdot}9 \times 16{\cdot}29 \times 4\frac{1}{8} \times (31 \times 2) \times 2}{33000} = 782{\cdot}45$$

A dynamometer was fitted to the screw shaft, and gave a mean thrust of 12,815½ pounds; the power exerted in propelling the vessel would therefore be

$$\frac{12815\frac{1}{2} \times 968 \text{ (speed of vessel in feet per minute)}}{33000} = 375{\cdot}92 \text{ horses.}$$

If we now estimate the power required to work the engines, overcome the load on the air pump, &c., at 2 lbs per square inch of steam piston, an estimation that will probably vary but little from the truth, we shall have 96·06 horse power absorbed in working the engines alone.

Taking from Morin's experiments, the friction of the load at 7½ per cent. of the power applied, and considering the power applied to be that developed by the engines, minus that absorbed in working the engines, we have for the power absorbed in the friction of the load, 51·48 horses.

Collecting the above, we have the following for the disposition of the power in the "San Jacinto:"

Slip of the Screw,	26·27	per cent. or	205·55	horse power.
Propelling the Vessel,	48·04	" "	375·92	"
Working the Engines,	12·28	" "	96·06	"
Friction of the Load,	6·58	" "	51·48	"
Leaving to be absorbed in the friction of the screw surface on the water, and the direct resistance of the edges of the blades, &c.,	6·83	" "	53·44	"
	100·00		782·45	

From the above table it will be perceived that the total losses of power by the screw were, 26·27 per cent. of the total power developed by the engines in slip, and 6·83 per cent. in the friction of the screw surface in the water, &c., making 33·1 per cent.

It may be supposed that the slip of the "San Jacinto's" screw was too great for the best economical effect, and that if greater surface had been given to it, a better result would have followed. This opinion, though plausible, is not sustained by experiment.

The best proportioned screws, ascertained from a trial of many, for giving the highest speeds of vessel, were found in the small experimental vessels, "Archimides" and "Dwarf," to have slips of 25 and 30½ per

cent. The screw giving the highest result in the experimental vessel, "Napoleon," had also a slip of 25 per cent.; which was likewise about the slip of the screw giving the best result in the "Rattler."

In using any propelling instrument for the transmission of power, a portion of that power is unavoidably lost in misapplication. In the common paddle wheel, this misapplication consists in giving a retrograde motion, in a direction parallel to the vessel, to the water acted on by the paddles, termed dip, and to a vertical depression and lifting of the water, termed oblique action—the total losses by the paddle wheel being the sum of the losses by slip and oblique action. In the screw, there is the same loss by slip, but the loss by oblique action, which does not exist with the screw, is replaced by another, viz: that of the friction of the screw surface on the water. The total losses by the screw would then be the sum of the losses by slip and friction.

It has been ascertained by experiment, that the friction of solid surfaces on water is directly as the surface and as the square of its velocity. In the same screw then, with equal velocities, the friction is as the surface; but the slip is by no means as the surface, but in a far less proportion, to be ascertained only by experiment.

The only reliable experiments made with this view, that I am in possession of, are those by Bourgois, made by order of the French government; and one of them is nearly a parallel case to the originally proposed and actually executed screws of the "San Jacinto."

Bourgois tried a screw of 6 blades, having a surface of $\frac{6}{7}$ths of the area of the diameter of the screw, viewed as a disk. The slip obtained was 37 per cent. Two of the blades were now omitted, and the remaining four placed equi-distant. The screw in this state was composed of 4 blades, having a surface of $\frac{4}{7}$ths of the area of the diameter, viewed as a disk; the slip was now found to be $38\frac{1}{10}$ per cent., or only $1\frac{1}{10}$ per cent. more than before. This experiment was pushed still further by the reduction of another blade, leaving the screw composed of 3 blades, with a surface of $\frac{3}{7}$ths of the disk; the slip now obtained was $41\frac{8}{10}$ per cent., or only $4\frac{8}{10}$ per cent. more than the first slip; showing that a reduction in the surface of one-half, only increased the slip from 37 to $41\frac{8}{10}$ per cent., or $11\frac{1}{2}$ per cent. of the last slip.

Supposing now the screw as originally proposed for the "San Jacinto," had been used, having about $1\frac{3}{4}$ths the projected and $3\frac{1}{2}$ times the helicoidal surface of the one actually used; and supposing the increased projected surface had decreased the slip in the above proportion of $11\frac{1}{2}$ per cent., or $3\frac{2}{10\,0}$ per cent. of the actual slip of the "San Jacinto's" screw: there would then have been obtained a slip of $(26\frac{27}{10\,0} - 3\frac{02}{10\,0})$ $23\frac{1}{4}$ per cent. But the helicoidal surface having been increased $3\frac{1}{2}$ times, the friction would also have been increased in nearly that proportion; and as we see the friction with the present surface amounts to $6\frac{83}{10\,0}$ per cent., it would have amounted with the $3\frac{1}{2}$ times surface to $23\frac{9}{10}$ per cent. Supposing the total power developed by the engine to have remained the same, in which case the available power for the propulsion of the vessel would have been diminished by $(23\frac{9}{10} - 6\frac{83}{10\,0})$ $17\frac{7}{10\,0}$ per cent., and increased $3\frac{2}{10\,0}$ per cent. by the lessened slip, leaving a balance of diminution of $(14\frac{7}{10\,0} - 3\frac{2}{10\,0})$ $17\frac{5}{10\,0}$ per cent. of the available power for propulsion; and as the speed of the vessel is in proportion to the cube

roots of the powers applied, the speed would have been to the present speed in the proportion of $\sqrt[3]{1{\cdot}000}$ to $\sqrt[3]{0{\cdot}855}$; or, instead of being 11 statute miles per hour, would have been 10·44 statute miles per hour; always supposing the engines to develope the same power. The sum of the losses then of the proposed screw would have been $(23\frac{25}{100}+23\frac{9}{10})$ $47\frac{15}{100}$ per cent., instead of $33\frac{1}{10}$ per cent., the sum of the losses by the present screw. The present screw is therefore more economical by $14\frac{5}{100}$ per cent. of the power, without reckoning the practical advantages of decreased weight and cost of manufacture.

The screw proposed by the Board, and used on the "San Jacinto," has not the proportions they would have adopted, had they been designing the entire machinery of the vessel; but the engines, boilers, and stern of the ship having been completed before their labors began, they had only to adopt the best screw that existing conditions permitted. A longer screw was impracticable, with the stern of the vessel as built, and the surface was limited in that direction; more than four blades of the same length would have given more surface, but that surface would have been nearly useless, as the blades would have been so close together as to prevent the access of water of sufficient solidity, beside having the additional resistance of the additional edges of the blades. Nor could increased surface be obtained by lessening the pitch; for such was the complex design of the engines, the multitude of its connexions and moving parts, that it was unsafe to work them up to a speed that would be necessary, with a reduced pitch, to give the vessel the proper speed; in addition to which, the boilers would not have supplied steam enough for the increased number of revolutions.

Hull.—The "San Jacinto" is 203 feet long on keel, 210 feet long at load line, 215 feet long between perpendiculars, and 237 feet extreme length. The beam moulded is 37 feet, extreme 38 feet. Depth of hold $23\frac{1}{2}$ feet. Deep load draft $16\frac{3}{4}$ feet. Depth of keel and false keel 15 in.

Displacement in tons of 2240 lbs., at launching draft of $10\frac{1}{2}$ feet,			1080.		
"	"	"	$11\frac{1}{4}$ feet draft,	1156 tons and	1764 lbs.
"	"	"	$13\frac{1}{4}$ "	1489 "	1242 "
"	"	"	$15\frac{1}{4}$ "	1838 "	1658 "
"	"	"	$17\frac{1}{4}$ "	2202 "	2055 "
"	"	"	$16\frac{3}{4}$ " (load draft)	2150 "	
"	"	"	per inch of draft at load line,	$17\frac{1}{2}$ "	
Area of immersed amidship section at			$11\frac{1}{2}$ feet draft,	273·81	square feet.
"	"	"	$13\frac{1}{4}$ "	346·55	"
"	"	"	$15\frac{1}{4}$ "	420·05	"
"	"	"	$17\frac{1}{4}$ "	496·05	"
"	"	"	$16\frac{3}{4}$ "	477·05	"
"	"	"	$15\frac{3}{4}$ "	438·56	"

The "San Jacinto" is barque rigged, and spreads 16,500 square feet of canvass.

Cost of materials for the hull,	$85,455
" labor "	70,566
" materials for masts and spars,	1,069
" labor " "	3,851
" materials for boats,	574
" labor "	1,546
" materials for rigging and blocks,	1,018
" labor, " "	4,512
Other items,	25,000
	$193,591

The data furnished by the trial trip of the "San Jacinto," may be made available in determining *a priori* the friction of any other screw of known dimensions and revolutions per minute. We have seen that the friction of the screw of the "San Jacinto" amounted to 53·44 horse power; supposing the balance of the total power developed by the engines, after deducting for the "slip of the screw," for "propelling the vessel," for "working the engines," and for the "friction of the load," to be absorbed in the friction of the helicoidal surface on the water; the direct resistance of the edges of the blades being probably but small, as they were sharply chamfered. The screw surfaces were rubbed smooth.

In order to make this data applicable to other screws, the expression for friction must be reduced to some unit of weight, acting with a given speed on some unit of surface. The pound avoirdupois, 10 feet per second, and the square foot, are the most convenient for our purpose.

From many experiments, it appears that the law regulating the quantity of friction of solids on fluids, is different from that regulating the quantity of friction of solids on solids, and instead of being proportional to pressure and velocity, is proportional to pressure, surface, and the square of the velocity. Assuming these hypotheses to be correct, we will determine the value of the friction of one square foot of helicoidal surface, moving with the velocity of 10 feet per second, from the data of the "San Jacinto," premising—

As every helix of a helicoidal surface, from axis to periphery, is of a different length, increasing as the periphery is approached, and as each helix moves through its length per revolution of the screw, and as all the helices perform the same number of revolutions in the same time, it follows, that each helix will have a different velocity; and taking a helix to represent an infinitely narrow surface of the helicoid, it also follows that these different surfaces normal to the helices will have different frictions, in the proportion of the squares of velocities and the areas of the surfaces. It is then necessary to ascertain the velocities and areas of these surfaces. The problem can be solved approximately, geometrically, with but little trouble, and with more than sufficient accuracy for practical purposes.

By this method, the surface of the screw projected on a plane at right angles to the axis, that is, considered as a disk, is divided by concentric circles into any number of rings or *elements;* the greater the number of elements taken, the closer the result approximates the truth. The centre line of each element is taken as the length of the element, and is determined as follows:

The development of a helix upon a plane is the hypothenuse of a right angled triangle, whose base is the circumference normal to the distance of the helix from the axis considered as a radius, and whose height is the pitch. We have, therefore, the base and height of a right angled triangle, given to find the hypothenuse, and the hypothenuse or helix multiplied by the breadth of the element gives its area.

We have now all the quantities for the calculation excepting the pounds avoirdupois per square foot of surface for the speed of 10 feet per second. This we obtain by representing the unknown weight by x, and making the calculations with it for each element; then summing up the column so obtained, and dividing by 33,000, we obtain the expression in horse power

multiplied by x. Making these calculations on the screw of the "San Jacinto," and returning to the data furnished by that vessel, when the friction of the helicoidal surfaces is given at 53·44 horse power, we ascertain, by dividing the 53·44 by the horse power multiplied by x as above obtained, the unknown weight in pounds avoirdupois—observing that the helicoidal surface must be taken for *both* sides of the screw.

In this manner the friction of one square foot of helicoidal surface moving in its helical path with a velocity of 10 feet per second, is determined from the data of the "San Jacinto," to be 0·6195 pounds avoirdupois.

An examination of the subjoined table will explain the *modus operandi* without further illustration.

It may be thought that the friction from the propelling face of the blade is greater than the friction from the opposite face, by reason of its pressure on the water. Should this be the case, however, the aggregate frictions from both sides of the blade would remain the same as though this pressure did not operate in inequality; for it is evident, that if this pressure *increases* the friction on the pressing face, it must, in an equal degree, decrease the friction on the face removed from the pressure.

Indicator Diagrams.—No. 1. From top of port cylinder; mean effective pressure per square inch, 14·9 lbs; revolutions of screw and double stroke of piston per minute, 31.

No. 2. From bottom of port cylinder; mean effective pressure per square inch, 14·95 lbs; revolutions of screw and double stroke of piston per minute, 31.

No. 3. From top of starboard cylinder; mean effective pressure per square inch, 20·15 lbs; revolutions of screw and double stroke of piston per minute, 31.

No. 4. From bottom of starboard cylinder; mean effective pressure per square inch, 18·75 lbs; revolutions of screw and double stroke of piston per minute, 31.

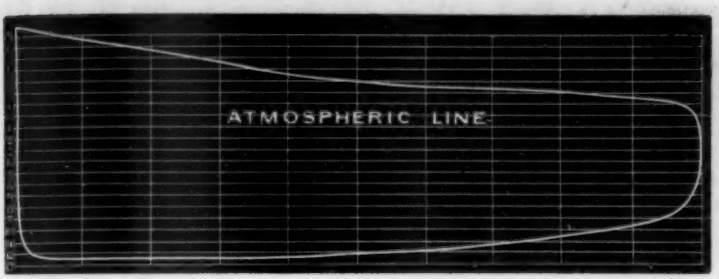
From the above and a number of other diagrams taken during the trip, with the engines working at 31 double strokes of piston per minute, the area of the mean effective pressures was 16·29 lbs. per square inch of piston.

Calculations on the Screw of the U. S. Steamship San Jacinto.

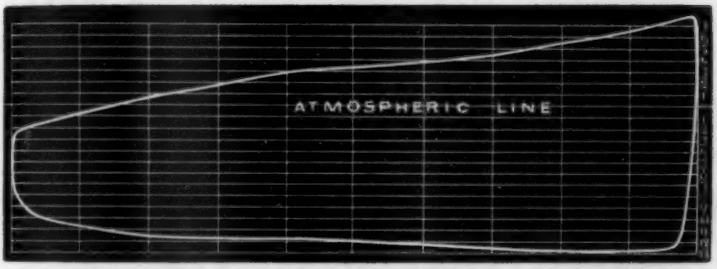
Diameter 14½ feet; length on hub, in the direction of axis, 2½ feet; length at diameter of 7½ feet, in direction of axis, 4 feet; length at periphery, in direction of axis, 4 feet; diameter of hub, 28 inches; pitch, 40 feet, expanding to 45 feet, mean 42½ feet; revolutions per minute, 31; number of blades, 4.

INDICATOR DIAGRAMS FROM THE U. S. STEAMER SAN JACINTO.

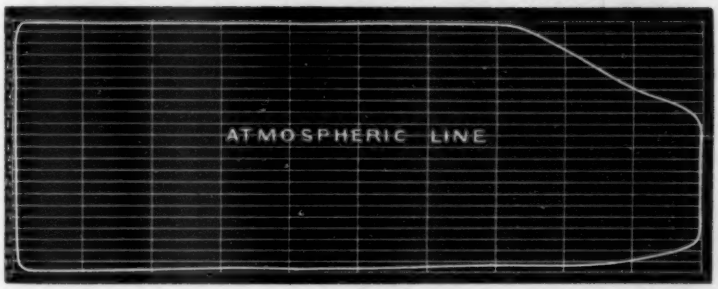
No. 1.



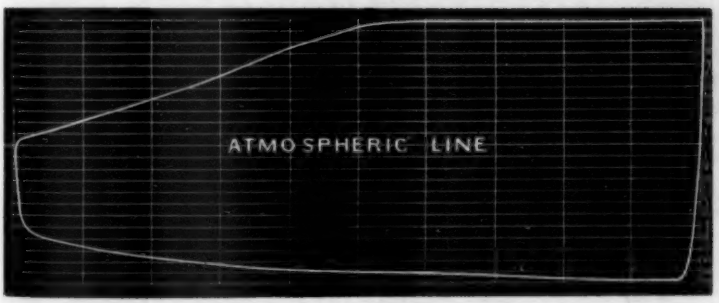
No. 2.



No. 3.



No. 4.



Pitch.	Radii of ele's.	Circumf'ces normal to radii of elements.	Lengths of Screw in direction of axis at radii.	Fractions of Pitch used.	Lengths of Elements for one convolution of thread.	Lengths of elem'ts used.	Breadth of elements.	Helicoidal surfaces of elements.	Speeds of ele's pr. sec.	Speeds of ele'ts pr. min.	Friction, *both* sides of screw.
A	B	C	D	$\frac{D\times4}{A}$	F	G	H	I	$\frac{J}{K}$	K	L
		$2B\times3{\cdot}1416$			$\sqrt{(A^2+C^2)}$	$F\times E$		$G\times H$	$\frac{60}{}$	$F\times31$	$\frac{J^3}{10^4}\times K\times2I$
Feet.	Feet.	Feet.	Feet.		Feet.	Feet.	Feet.	Sq. Feet.	Feet.	Feet.	$\times0{\cdot}6195$ lbs.
42·5	1·27	7·980	2·500	0·235	43·243	10·162	0·208	2·114	22·342	1340·53	17526·584
"	1·50	9·425	2·542	0·239	43·532	10·404	0·250	2·601	22·491	1349·49	21998·817
"	1·75	10·995	2·666	0·251	43·893	11·018	"	2·754	22·680	1360·84	23885·132
"	2·00	12·566	2·833	0·267	44·317	11·833	"	2·958	22·897	1373·83	26397·329
"	2·25	14·137	2·958	0·278	44·790	12·452	"	3·113	23·141	1388·49	28678·365
"	2·50	15·708	3·125	0·294	45·310	13·321	"	3·333	23·410	1404·61	31788·155
"	2·75	17·278	3·250	0·306	45·881	14·040	"	3·510	23·705	1422·31	34757·853
"	3·00	18·849	3·416	0·321	46·492	14·924	"	3·731	24·021	1441·25	38443·072
"	3·25	20·420	3·583	0·337	47·150	15·890	"	3·972	24·361	1461·65	43928·101
"	3·50	21·991	3·750	0·352	47·845	16·841	"	4·210	24·720	1483·20	47276·820
"	3·75	23·562	3·833	0·361	48·594	17·542	"	4·386	25·107	1506·41	51602·739
"	4·00	25·132	4·000	0·376	49·374	18·565	"	4·641	25·510	1530·59	57274·720
"	4·25	26·703	"	"	50·192	18·872	"	4·718	25·932	1559·95	62020·623
"	4·50	28·274	"	"	51·045	19·193	"	4·798	26·373	1582·40	65427·253
"	4·75	29·845	"	"	51·932	19·526	"	4·881	26·931	1609·89	70089·053
"	5·00	31·416	"	"	52·850	19·872	"	4·968	27·306	1638·35	75192·741
"	5·25	32·986	"	"	53·800	20·229	"	5·057	27·797	1667·80	80742·842
"	5·50	34·557	"	"	54·768	20·593	"	5·148	28·297	1697·81	86712·096
"	5·75	36·128	"	"	55·817	20·987	"	5·247	28·839	1730·33	93549·618
"	6·00	37·699	"	"	56·815	21·362	"	5·341	29·354	1761·26	100427·393
"	6·25	39·270	"	"	57·865	21·757	"	5·439	29·897	1793·82	108049·968
"	6·50	40·840	"	"	58·946	22·164	"	5·541	30·455	1827·32	116356·658
"	6·75	42·411	"	"	60·040	22·575	"	5·644	31·021	1861·24	125248·404
"	7·00	43·982	"	"	61·160	22·996	"	5·749	31·599	1895·96	134846·379
"	7·25	45·550	"	"	62·298	23·424	"	5·856	32·187	1931·24	145167·621
"	7·431	46·690	"	"	63·136	23·937	0·125	2·967	32·620	1957·22	76559·049
						Helicoidal Area of Screw,		112·677			1763947·285

$$\frac{1763947{\cdot}285}{33000}=53{\cdot}45. \qquad \frac{J^3}{10^4}\times K\times2I\times x=2847372{\cdot}54\,x;\text{ and}$$

$$\frac{2847372{\cdot}54\,x}{33000}=86{\cdot}284\,x;\text{ and as }86{\cdot}284\,x=53{\cdot}44,\ x=0{\cdot}6195.$$

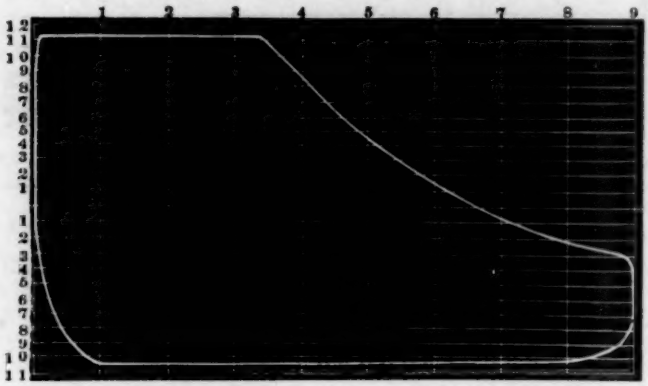
Comparison of the Results Obtained from the Screw of the San Jacinto, and the Paddle-Wheel of the Saranac.

Since writing the foregoing, I have obtained the log of the sister steamer Saranac, which enables me to make a comparison between the results obtained from the paddle wheel of that vessel, and the screw of the San Jacinto.

During the passage of the Saranac from Norfolk, Va., to New York, Oct. 15th, 16th, and 17th, 1850, the mean speed for 31 hours was 9·13 knots by log; revolutions of the wheels, 14·64 per minute; steam pressure in boilers per gauge, 13⅛ lbs. per square inch; vacuum in condenser per gauge, 27 inches; throttle one-fourth open; cut off at 3½ feet from commencement of stroke; smooth sea and *very* light breeze ahead Mean draft of vessel, 15 feet 9 inches. Two inclined engines, cylinders 60 inches diameter, by 9 feet stroke.

Common paddle wheel, 28 feet diameter, 22 paddles in each wheel; each paddle 9 feet by 30 inches; immersion, lower edge of paddle 4½ feet.

Indicator diagram from steam cylinder of the U. S. Steamship Saranac.



The mean effective pressure in the cylinder computed from the accompanying indicator diagram, taken under the above conditions, was 15·5 lbs. per square inch. The horse power developed by the engines would therefore be

$$\frac{(2827{\cdot}44 \times 15{\cdot}5 \times (9 \times 2) \times 14{\cdot}64)2}{33000} = 699{\cdot}92$$

Taking the knot at 6082⅔ feet, as used in the British Navy, 9·13 knots would be 10·518 statute miles. Taking the cubes of the speeds as the measure of the effects produced, and the indicated horse power as the cost of propulsion, and reducing them to proportionals; we shall have

	Powers.	Effects.
San Jacinto, ...	1·1291	1·1438
Saranac, ...	1·0000	1·0000

and $\frac{1{\cdot}1438}{1{\cdot}1291} = 1{\cdot}0130$,

that is to say, the application of the power with the *screw* in the San Jacinto was more efficient than with the paddle wheel in the Saranac, in the proportion of 1·0130 to 1·0000; or the two systems in these particular cases, may be considered as equally good.

The slip of the centre of reaction of the Saranac's paddle wheel was 23·7 per cent., which is about the usual average given. The loss by oblique action calculated as the squares of the sine of the angles of incidence of the paddles on the water was 13·3 per cent. The sum of the losses by the paddle wheel being 37 per cent. The Saranac's paddle wheel thus gave as favorable results as are found in sea-going steamers, and the equal effect obtained from the screw of the San Jacinto, show it to have very perfect proportions.

The Saranac, when she commenced the above noted 31 hours steaming, had only 231·837 pounds of coal on board.

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*Diving Vessels.**

In our late sojourn in Paris our attention was attracted to a diving apparatus working on the river Seine, in front of the Institute. It is a new and happy modification of the diving-bell, invented by M. Cave, the eminent engineer, for the purpose of descending to the bottom of rivers, and carrying on works there with greater facility than by the ordinary diving-bell. On the front of a dredging vessel is placed a large chamber, made of sheet-iron, having the form of an elongated hemispherical cup, 22 feet 9 inches in diameter, and 16 ft. 3 in. in height. In the centre of the bottom of the vessel there is a large opening which communicates with the river, and in it is placed vertically a large cylinder of sheet-iron, open at either extremity, and which can, by means of grooves, be lowered to any depth that may be required. When it is desired to examine the bottom of the river, it suffices to lower the cylinder; and, by the aid of an air-pump, a large quantity of compressed air is forced into the chamber. The water by that means is expelled underneath the cylinder, until at length the bottom of the river is left dry. The workmen can then descend inside the cylinder, and proceed with the work without any difficulty.

For communicating from without with the chamber, there is provided an ante-chamber, for persons to go in and out without allowing the compressed air to escape from the inner chamber. The doors of the inner chamber are hermetically closed, by which means the loss of compressed air is small, and is easily replaced. For the purpose of opening the inner door, it is necessary to open a valve to allow a small quantity of air in the inner chamber to escape into the ante-room, to restore a balance and make the pressure the same on both sides of the door. And a similar contrivance is necessary in the outer door; but before the valve is opened in the outer door, care must be taken to close the inner door and valve. There is another contrivance for forming an air-tight connexion between the vertical cylinder before described and the chamber. This is effected by a flexible joint or tube made of leather; one end is fastened to the bottom of the chamber and the other to the top of the cylinder. This leather flexible tube

* From the London Architect for September, 1851.

allows some play in the cylinder, so as to adapt it to various depths of water or variations in the depths of the river. The compression of the air is very easily accomplished by the steam engine which usually accompanies dredging vessels. The engine works two air-pumps, which communicate by a pipe to the chamber, and supply compressed air at discretion; of course, the density of the air must be in proportion to the depth of the water. It would appear that the workmen do not feel any particular difficulty in working in such an atmosphere; the only inconvenience in the augmentation of the density of the air is a slight pressure and noise in the ears. This vessel on the Seine is only an experimental one, to show that all descriptions of work can be performed under water with the greatest facility. M. Cave has already established two similar vessels for scouring the mud-banks of the Nile. The dimensions of them are much larger, the cylinders being 29 ft. 3 in. by 19 ft. 6 in.

Exposition of Foucault's Experiment.

To the Committee on Publications of the Franklin Institute.

It is somewhat surprising to observe that in all the explanations of Foucault's Pendulum Experiment which have appeared, not one has given, so far as I have remarked, a full exposition of its phenomena, and many have made false statements of its movements.

I propose briefly to consider its most obvious phenomena, and offer the accompanying exposition to the Institute, for disposal as it may think proper. J. S. Brown.

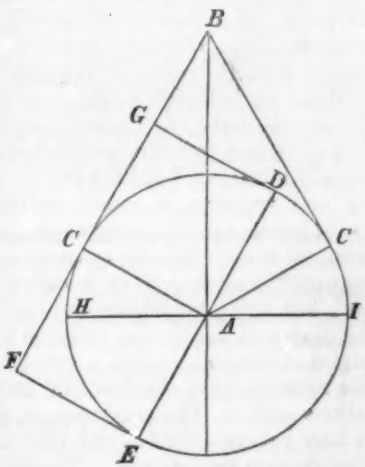
Washington, D. C., October 23, 1851.

The fact that a pendulum will invariably oscillate in the same plane, or in planes generated by the revolution or progression of the original plane, whatever may be the motion of its point of suspension, is the principle on which the phenomena of the experiment of Foucault depends. Yet the pendulum in this experiment, except at the equator and the poles, is supposed to depart from this very law, which rules its movements. For consider a moment. Having premised the obvious fact, that the motion of the earth in its orbit has nothing to do with the deviation of the pendulum, since its axis occupies positions ever parallel in every part of its orbit; and that in considering this experiment, we may therefore suppose the earth to have its one motion round its axis;—suppose a pendulum to commence oscillating in any direction, in any latitude, and to continue oscillating during an entire revolution of the earth. As it must constantly move in the same plane, or in planes produced by the revolution of its original plane of oscillation, when the earth has made precisely one revolution, the pendulum must, at that moment, oscillate in precisely the same plane in which it moved when first set in motion. The necessity of this is at once seen. At the equator it is said not to have deviated, which is true; at the poles it is said to have deviated through an entire circle, which is also true. In intermediate latitudes its deviation is said to have varied from nothing to an entire circle, proportional to the sines of the latitude, which is *not* true; for, if so, its planes of oscillation at the

beginning and end of the revolution would not then coincide. But that is directly contrary to the fundamental law of its motion. But it may be said that in all intermediate latitudes it does deviate more or less, but nowhere sufficiently to complete a circle in one revolution of the earth. How can this inconsistency be explained into a consistency? Having met the difficulty I must conquer it, and propose to do so at once, by showing that the pendulum can have *five* varieties of movement consistent with the fundamental law of its deviation, and that it actually exhibits all those five movements in different positions on the earth.

Let A C, in the diagram, be a radius of the earth, terminating in the point where the pendulum commences its oscillation; hence the line B C represents the cotangent, and A B the cosecant of that latitude. The revolution of the right-angled triangle A B C about the side A B, corresponding with the revolution of the earth around its axis, will generate a double cone, one produced by the line B C, which is tangent to the meridian at each moment of the revolution, and represents the original direction of the pendulum's motion; the other generated by the radius A C, through which the plane of oscillation invariably passes. The planes of oscillation are described by the revolution or vibration about the line A D, passing through the centre of the earth, and parallel with the cotangent B C at the commencement of the revolution, of the plane D E F G, the original plane of oscillation. The angle which this plane makes with the generating plane A B C throughout their revolution shows the deviation of the pendulum, and depends on the latitude of the place and the motion of the earth on its axis for the given time.

Let the pendulum be suspended over the equator; the line B C is then parallel with the line A B, and the axes of the two generating planes coincide, making their angle of deviation nothing during their revolution. This is the first kind of deviation, which is *no* deviation.



Next, let the pendulum be placed in any latitude between the equator and 45 degrees. The axes of the two revolving planes make an angle with each other equal to the latitude; and as the plane of oscillation must always pass through the radius A C, it revolves with the triangular plane A B C, coinciding with it at the commencement of the revolution, and at the end of half a revolution, and reaching its maximum of deviation near the end of the first and third quarters of the revolution of the earth. Therefore, in all latitudes between 0° and 45°, the deviation of the pendulum gradually increases about 6 hours, and then gradually decreases to nothing at the end of 12 hours; then increases again at the next quarter of a revolution. This is the second variety of movement.

Then let the latitude be 45°. Here the plane of oscillation also revolves with the plane of A B C, but makes only one-fourth of a revolution to one-half of a revolution of the earth, and one-half a revolution to an entire revolution of the earth. Hence at the end of 12 hours the angle of deviation has reached 90°, and in 24 hours, or at the end of one revolution of the earth, 180°; the pendulum then moving in the original plane of oscillation, but actually oscillating in a direction opposite to its original. This is the only anomaly in its movements, but not contrary to the fundamental law of its motions.

Next, suppose the latitude any between 45° and the poles. The plane of oscillation here does not revolve, but vibrates by a reciprocating motion about its axis, and thus causes the angle of deviation to continually increase in variable increments throughout the entire revolution. At the end of half a revolution, the two generating planes coincide, their angle of deviation having reached 180°. At the end of the other half of the revolution they again coincide, their angle having reached a full circle. Thus the deviation of the pendulum in these latitudes, equals a whole circle in every revolution of the earth, but is slower in the first, and faster in the last part of each half revolution. This variation is greater the nearer the latitude to 45°, and less the nearer to 90°, till at the poles it is nothing, and the rate of deviation becomes constant, as will presently be seen. This constitutes the fourth variety of movement.

Finally, suppose the pendulum at one of the poles. Here the angle of the axis of the generating planes is 90°, and the oscillating plane does not move, the cotangent B C becoming perpendicular to the axis A B, and describing a circle in its revolution. Hence, it also describes a circle whose plane is perpendicular to that of oscillation; and the increase of the angle of deviation is constant, coinciding with that of the earth's revolution, and reaching an entire circle in each revolution. This constitutes the fifth variety of the pendulum's movement.

Thus, we find that at the equator the deviation of the pendulum is nothing; between the equator and 45° it increases to a certain angle, and then decreases to nothing each half revolution of the earth; at 45° it continually increases, reaching 90° each half revolution of the earth; between 45° and the poles, it makes an entire circle at each revolution of the earth, but in variable increments; and at the poles, it makes, in the same time, an entire circle in constant increments. In every latitude at the beginning and end of each entire revolution, and in every latitude but 45°, and at the beginning and end of each half revolution of the earth, the planes of oscillation coincide at 45°, the two planes being at right angles at the end of half a revolution. These generating planes have like movements in the first half and last half of each revolution, but in reverse order. The maximum of deviation between 0° and 45° varies in time between the 6th and 12th, and between the 12th and 18th hours, according to the latitude. Twenty-four hours are taken above as the measure of one revolution of the earth, which is not quite exact; but the error is trifling.

It remains now to give a rule for determining the angle of deviation at all times, and in all latitudes. The angle of deviation is a function of the latitude in which the pendulum is suspended, and the revolution of

the earth on its axis. The following formulas will give the angle in every case.

Let L represent the latitude of the place; T the time of oscillation in degrees of the earth's revolution; x, the angular motion of the line A C (in the diagram) on the plane of oscillation; D, E, F, G, and y, the required angle. Then

$$\text{Sin. } x = \frac{\text{sin. } 2\text{ L} - \text{sin. } 2\text{ L} \times \text{cos. T}}{2},$$

and

$$\text{Cos. } y = \frac{\text{cos. L} - \text{sin. L} \times \text{sin. } x}{\text{cos. L} \times \text{cos. } x}.$$

For unimaginative mathematicians, who cannot see the movements of the revolving planes in the diagram, by the eyes of their mind, a convenient way to obtain a clear conception of them is, to cut out the triangle A B C, for the various latitudes desired from paste-board or veneering; and a plane to represent the plane of oscillation D, E, F, G, from like material. Then mark on a sheet of paper, a point indicating the centre of the earth, and a line to represent the line A B. Place the triangle A B C, as shown in the diagram, and the plane of oscillation at an angle equal to the latitude from that line. Then revolve the triangle A B C, and with it the plane of oscillation, taking care to keep it in contact with the line A C. The angle formed by the two planes in various parts of the revolution will represent the deviation of the pendulum, and the paper on which the planes are placed will be the original plane of oscillation.

The movements of the pendulum as here elucidated, are simply mathematical deductions from the supposition that the true cause is assigned for the phenomenon of the pendulum's deviation, which I doubt not. To ascertain by experiments if the actual movements coincide with the theoretical, would be a demonstration of the assigned cause. The principal difficulty would be to cause a pendulum to oscillate a sufficient time to observe all the effects spoken of above. I would suggest that a pendulum be caused to oscillate in a vacuum, which would probably, if well arranged, oscillate any desirable length of time, and, if in a glass vessel, would allow all its movements to be readily noted, while freedom from surrounding disturbances would be insured.

Note.—Our correspondent is in error in supposing that no explanation of this experiment has been given, involving a full exposition of its phenomena. The mathematical theory of it given by M. Binet, in the *Comptes Rendus* of the Academy of Sciences, is very complete, and the demonstration in our own Journal, by Mr. C. J. Allen, (page 103,) appears to us to be thoroughly correct, and may be easily extended to include all the phenomena. EDITOR.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, October 16, 1851.

S. V. Merrick, President, in the chair.
John F. Frazer, Treasurer.
Isaac B. Garrigues, Recording Secretary.
The minutes of the last meeting were read and approved.
Communications were read from the American Institute, New York,

the Mechanic's Institution, Wheeling, Virginia, and the Maryland Institute, Baltimore, Maryland.

Donations were received from George Harding, Esq., and Dr. L. Turnbull, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer's statement of the receipts and payments for the month of September was read.

The Board of Managers and Standing Committees reported their minutes.

New candidates for membership in the Institute (32) were proposed, and the candidates (7) proposed at the last meeting were duly elected.

On motion it was

Resolved, That the American Institute, New York, and the Maryland Institute, Baltimore, have the thanks of this Institute for their civility in extending invitations to the Institute to visit their exhibitions.

Resolved, That the President be authorized to appoint delegates to visit the exhibitions.

Resolved, That the Franklin Institute of the State of Pennsylvania, tender their congratulations to the founders of the new association at Wheeling, Va., for the promotion of the arts and the interests of mechanics, and express to them their warmest hopes for their success, towards which, no assistance which it is in the power of the Institute to grant, shall be wanting.

Resolved, That the Board of Managers be requested to inquire into the expediency of forwarding to the Mechanic's Institute of Wheeling, a copy of the publications of the Institute, and to institute with them a system of exchange of publications.

Dr. Rand brought before the Institute the Thermometrical Ventilator of Mr. Peter Teal, of this city, the action of which depends upon change of temperature. It is of a circular form, similar to the ordinary furnace register. The movable plate or valve being fixed upon a shaft with delicate bearings, and accurately balanced. Upon the side of the valve is an inverted syphon with a bulb at one end, the other being open; the lower part of the tube contains mercury, the bulb atmospheric air; an increase of temperature expands the air in the bulb, drives the mercury down one side and up the other, thereby destroying the balance and causing the valve to open by turning upon its axis. A diminution of temperature contracts the air in the bulb, causes the mercury to rise in the side of the tube, and closes the valve.

It is adjustable to any degree of temperature by means of movable weights attached to the shaft.

A number of specimens of cotton fibre were exhibited, prepared by Dr. Wetherill by Mercer's process, employing a solution of caustic potash, and some interesting remarks were made by G. W. Smith, Esq., who had examined the fibre by the aid of the microscope.

Mr. Thomas J. Weygandt, exhibited an improved magneto-electric machine, for medical use, with a new arrangement by which the shock is graduated by means of a glass tube, in which a wire is made to communicate with water so as to produce at first a slight shock; by gradually pressing down the wire attached to a spiral spring, the shock is received in its full force.

Mr. Charles E. Smith, made the following observations in regard to rolled tapered iron, illustrated by two specimens from the establishment of Reeves, Buck & Co., of Phœnixville.

Taper iron, or iron regularly diminishing in thickness, or width, or both, from one end to the other, has heretofore been made almost altogether by the hammer. The production of any such forms by the rolling mill, has been heretofore thought by many persons, to be impossible.

The principle and the merits of Mr. Clay's patent will perhaps be more readily understood if we first briefly review the nature of the attempts previously made. I believe among the first of these was the use of *eccentric rolls:* but the length of the taper was always limited by the length of the circumference of the roll, and the pressure was so unequal in the different parts of the revolution (the whole taper being necessarily given in a single revolution) that it was soon abandoned.

The next trial was with *bevel-wheels,* placed on the heads of the screws which hold down the top roll. This succeeded in part, but it was extremely limited in its application, and required a new pair of wheels for every change in the *rate* of taper. It was also necessary to reverse the motion of the wheels after the passage of each bar, in order to run up the screws before entering another bar.

Revolving eccentrics bearing on the journals were then suggested, but they were more complicated than eccentric rolls, without possessing any advantages over these in other respects.

Lastly, a *hydrostatic press* was proposed to force down the roller as the iron was passing through, but this was found not to act with sufficient promptness.

Mr. Clay's plan is more simple and more efficient than any of these, and at the same time it is unlimited in the length or rate of taper that may be obtained by it.

The principle on which it acts is that of hydrostatic pressure, or more properly, *hydrostatic resistance.* A small chamber, similar to that of the common hydrostatic press, is set on the top of each housing; the closed end of the press being uppermost, and a plunger entering from below; but instead of water being forced *into* the press, the chamber is at the first, filled with water, and the pressure of the iron in passing between the rollers, tends to lift the top one, which is held down by the plunger. An escape pipe provided with a valve, is inserted into the top of the chamber. When any upward pressure acts on the top roll, it is communicated by the plunger to the water, which escapes through the valve, and the roll rises.

When the valve is partially closed, the water escapes more slowly; and the rise of the roll, and, consequently, the taper of the iron, are more gradual.

Any rate of taper may thus be had by regulating the size of the opening of the escape valve. If the water is all driven out before the bar is entirely through the rolls, the top roll ceases to rise, and the iron becomes parallel from that point. Then, if the ends of the bar be reversed, and it be again passed between the rolls, the parallel portion will become tapered; thus we can get a bar,

First, Regularly tapered from end to end.

Second, Tapered part of its length, and parallel the remainder.

Third, Tapered from each end to a point any where in its length.

Fourth, Tapered at each end and parallel in the middle.

Fifth, Alternately tapered and parallel; (by alternately opening and shutting the valve as the iron is passing through the rolls.)

Sixth, Tapering in an increasing or diminishing ratio, (by gradually opening or closing the valve as the iron goes through.)

The principal use to which this iron has been thus far applied, is to form iron knees, for ship building; the storage of a vessel constructed with iron knees being about twelve and one-half per cent. more in bulk than that of one built with wooden knees. The arms of paddle wheels for steamers are flat bars, tapered either upon their edges or upon their sides. Short switches and pointers on railroads are regular tapers. Locomotive pedestals are made from bars tapered at each end and parallel in the middle. The common carriage axle is square next the journal, and tapered in thickness to the middle. Straps for walking beams and connecting rods and all kinds of levers are tapered. Anchor shanks are tapered "rounds," which have been passed through flat rolls, and have thus acquired an oval section. Windlass necks are tapered "squares." There are many things now made of common parallel bars of iron, which would be made of taper iron, were it not that the cost of forging is greater than that of the superfluous iron now used.

Mr. William Irwin, of Philadelphia, formerly of Chester, Pa., exhibited a working model of his "improved method of raising sunken vessels," for which he has recently obtained a patent, and explained the same to the meeting. This seems to be, in substance, an ingenious combination of "receivers," made of some water-proof material, and capable of exhaustion and inflation, attached to chains to which are fastened "purchase blocks" with "jamb-rollers and purchase halyards," together with a wedge of twisted rope in the shape of a marlin spike, used to prevent the halyards from slipping when the lifting power is being applied. When the position and dimensions of the vessel, and the weight of her cargo, are duly ascertained, chains of the necessary strength and receivers of sufficient power are selected, and the apparatus properly and readily arranged around the vessel; the receivers are then inflated, and the sunken ship is raised to the surface. The invention appeared to be both novel and meritorious, and can be applied, (as stated by the patentee,) to "supporting vessels off shore, floating them off and over reefs, rocks, and shoals, &c."

BIBLIOGRAPHICAL NOTICES.

Marine and Naval Architecture.

The United States now stand confessedly at the head of all maritime nations in Marine and Naval Architecture. Our ships command, by their speed and beauty of outline, not only the admiration of all who behold them, but the highest commercial freights that are to be obtained; and whether the talents of our builders are developed in pilot boats, yachts, ships, or steamers, the result for the last five years at least has been con-

stant and increasing success. An acquaintance with several of our best ship builders in this city and New York, enables me to say with confidence, that this success has been obtained by what are usually termed practical men—operative mechanics, who by industry and ability have risen in their profession, and been enabled to develope practically their ideas, and with each vessel to improve. Our fastest and best ships have been the result of the application of these men, and in direct opposition to nearly all received opinions. The scientific publications on the subject, with one or two exceptions, are the same at the present day as fifty years since, and the practical man may look almost in vain for any assistance from scientific works. This is owing to the fact, that scientific men have not *practically* applied themselves to the business, and what they have written upon the subject has been the result of second hand information, acquired from practical builders, or the speculations of their own brain. The elements of a good vessel are so many and so various, depending on the general duty to be performed, that nothing but close and continued application will answer the purpose. But while these results have been obtained by practical men in a manner *they* may claim as *their* own, still it is none the less true, that their success has been the result of a proper application of scientific principles. A work from an operative ship builder, with the true outlines of many of our best vessels fully explained, and their success accounted for on the correct development of well known principles, has been much needed; and I think such a publication will be found in a book recently issued in New York, by John W. Griffiths, Esq., on Marine and Naval Architecture. Mr. Griffiths has himself worked practically many years at the business, and has felt the want of such a work as he has now been enabled, by several years of study, to produce. The execution of the volume is very superior. All the drawings are to an accurate scale, and of themselves are worth treble the price of the volume. In addition to this, there are twelve chapters devoted to all the various important points that are to be considered in the construction of merchant or navy vessels, including sea steamers. The method of reasoning is one that will readily commend itself to practical men, and I have no doubt will be fully appreciated by all those of a scientific turn who are willing to investigate the subject; among which, however, cannot be classed the editor of the London Mechanics' Magazine, who has made a most furious onslaught in the May and June numbers of that publication; having said much that had better remained unsaid, for the articles bear the impression of ill feeling and great haste, much of which has no doubt been produced by the claims made by Mr. Griffiths, in behalf of *this country, against England in particular.* Notwithstanding all that has been said by the editor of that Journal, I venture to assert, that no work on Marine Architecture can be produced, that will be so useful to the ship builder of the present day, as the work of Mr. Griffiths; and I am happy to know that a second edition is soon to be issued, that will contain all the lines of the yacht America. It is unfortunate for the Editor of the London Mechanics' Magazine, that these lines have not passed through what he terms "the crucible of science for several centuries," for then he might have claimed them as his own. It is also unfortunate for him, that the builder who designed her is a practical man; and still worse, that